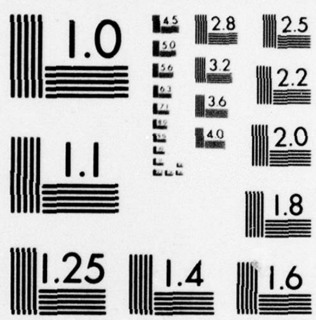
AD-A062 700 OFFICE OF THE PROJECT MANAGER CHEM DEMILITARIZATION I--ETC F/G 19/1
DEMILITARIZATION PLAN OPERATION OF THE CHEMICAL AGENT MUNITIONS--ETC(U)
MAR 77

UNCLASSIFIED DRCPM-DRD-TR-77020 NL

1 OF 2
AD
A062700


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3

DRCPM-DRD-TR-77020

LEVEL II





# OPERATION OF THE CHEMICAL AGENT MUNITIONS DISPOSAL SYSTEM (CAMDS) AT TOOELE ARMY DEPOT, UTAH





MARCH 1977

INCLOSURE NO. 11



## DEMILITARIZATION MACHINE TESTING & RELATED DATA

6

**DEMILITARIZATION PLAN**

**OPERATION**

**OF THE**

**CHEMICAL AGENT MUNITIONS DISPOSAL SYSTEM**

**(CAMDS)**

**AT**

**TOOELE ARMY DEPOT**, Utah.

Inclosure no. 11. Demilitarization Machine Testing and Related Data.

9 Final rept.

12 142 p.

14 DRCPM-DRD-TR-77020

| | |
|---|---|
| ACCESSION for | |
| NTIS | White Section |
| DDC | Buff Section |
| UNANNOUNCED | |
| JUSTIFICATION | |
| BY | |
| DISTRIBUTION/AVAILABILITY CODES | |
| Dist. | AVAIL. and/or SPECIAL |
| A | 23 22 |

11 MARCH 1977

**INCLOSURE NO. 11**

**DEMILITARIZATION MACHINE TESTS**

78 12 13 066



393 647

slt

TABLE OF CONTENTS

INCLOSURE NO. 11


| | SECTION NUMBER |
|---|---|
| ROCKET DEMIL MACHINE | 1 |
| PROJECTILE DEMIL MACHINE | 2 |
| PROJECTILE PULL AND DRAIN MACHINE | 3 |
| MINE DEMIL MACHINE | 4 |
| MORTAR DEMIL MACHINE | 5 |

TABLE OF CONTENTS

INCLOSURE NO. 11 SECTION I

ROCKET DEMIL MACHINE TEST SUMMARIES


| | PAGE NUMBER |
|---|---|
| THERMAL DEACTIVATION OF M55 ROCKET BURSTERS | 1 |
| M55 ROCKET PROPELLANT TEST | 3 |
| M61* ROCKET SAW TEST | 10 |
| COLD SAWING TEST SUMMARY | 20 |
| SLUDGE GENERATION TEST | 24 |
| EXPLOSIVE ACCUMULATION TEST OF SEGREGATOR | 29 |
| M61 ROCKET CASING BURN TEST | 30 |
| PROPELLANT IGNITION TEST | 32 |
| DRAIN TEST OF M61 ROCKETS | 34 |
| PUNCH AND DRAIN TEST ON INTERNALLY PRESSURIZED ROCKETS | 35 |
| MAINTENANCE OF ROCKET DEMIL MACHINE WEARING RUBBER | 36 |


*M61 Rockets used for test purposes are identical to M55 rockets except they contained a simulant (ethylene glycol) fill instead of nerve agent.

CONCEPT EVALUATION

CAMDS 6-1

1. Concept Evaluated - Thermal Deactivation of M55 Rocket Bursters.

2. Date - 5 Dec 1969.

3. Objective - To determine the probability of a high order detonation developing during the furnace deactivation of cut-up segments of the burster.

4. Evaluation Parameters.

a. Assumptions:

(1) The bursters will be filled with either Comp-B (60% RDX-39% TNT 1% wax) or Tetrytol (70% Tetryl-30% TNT).

(2) The bursters will be cut so that all segments expose the explosive freely to the heat and flame inside the retort.

(3) The fuze and its initiating charges are fed into the furnace at a feed rate that will nullify initiation of any burster segments.

b. Critical Reactions:

| | COMP-B | TNT | RDX | TETRYTOL | TETRYL |
|---|---|---|---|---|---|
| (1) Melting Temperature | 78-80°C | 81°C | 204°C | 68°C | 130°C |
| (2) Detonates after 100 hrs exposure to 100°C | 0% | 0% | 0% | 0% | 0% |
| (3) Bullet Impact Test-Explosions | 3% | 4% | 100% | 0% | 13% |
| (4) Explosion Temperature for 1 second | 368°C | 520°C | 316°C | 378°C | 314°C |
| (5) Decomposes or Ignites (5 seconds) | 278°C | 475°C | 260°C | 320°C | 257°C |
| (6) Flammability Index | 177 | 100 | 278 | Will not continue to burn | 244 |

c. TNT, RDX, & Tetryl were added to the table in para B, to compare what could happen if pockets of pure material existed in the basic mixture, i.e., Comp-B & Tetrytol.

5. <u>Anticipated Results</u> - Assuming an operating temperature of 227°C at the feed end and 593°C at the burner end, the table indicates:

All compositions should start melting as soon as they enter the retort.

Comp-B & Tetrytol should be decomposing or burning by the time they reach the 2nd section of the retort.

NOTE: Pockets of pure TNT or Tetryl could detonate at this point <u>if</u> confined.

6. <u>Conclusions</u>

It is concluded that the probability of a detonation of sectionalized bursters is very remote and if it did occur, the other segments should have burned to a point where the possibility of a mass detonation would be practically nil.

SUMMARY TEST REPORT*

CAMDS 6-2

1. Name of Test: M55 Rocket Propellant Test

2. Date: 1 June 1970

3. Test Objective: To determine if the rocket propellant in an M55 rocket motor could be initiated to cause a high order detonation.

4. Test Procedure: The tests were conducted in the following manner:

Test #1 - One-half pound of Comp C4 was positioned between the propellant and fin assembly.

Test #2 - One pound of Comp C4 was tamped in one cruciform and between the propellant and fin assembly.

Test #3 - Two pounds of Comp C4 was tamped in the cruciform and between the propellant and fin assembly (see Figures 1 and 2).

Test #4 - Two and one-half pounds of Comp C4 was tamped in the cruciform and between the propellant and fin assembly. (see Figures 1 and 2).

(In all the above tests a 1/4" hole was drilled in the fin assembly to allow for placement of the blasting cap and safety fuze.)

Test #5 - Two strands of primacord were positioned in each of the three sections of the cruciform.

Test #6 - Three strands of primacord were positioned in each of the three sections of the cruciform.

(In each of the above two tests, nozzle closure plugs were removed to accomodate the detonating fuze.)

Test #7 - Two pounds of Comp C4 was tamped in the cruciform and between the propellant and fin assembly. A plate 1/4" thick with a 1/4" hole in the center was also positioned between the propellant and fin assembly to keep the explosive gases from escaping. A 1/4" hole was drilled in the center of the fin assembly to accomodate the detonating fuze (Reference Figures 1 thru 4).

Test #8 - Two and one-half pounds of Comp C4 was tamped in the cruciform and between the propellant and fin assembly. A plate 1/4" thick with a 1/4" hole in the center was also positioned between the propellant and fin assembly to keep the explosive gases from escaping. A 1/4" hole was drilled in the center of the fin assembly to accomodate the detonating fuze (See Figures 1 thru 5).

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.



K-10

5. <u>Results</u>: The results of all eight tests were identical in that the propellant grain was broken and scattered over a wide area. The failure of the propellant to detonate or ignite was substantiated by the quantity of broken propellant recovered after each test.

6. <u>Conclusions</u>: Detonation of an M55 rocket warhead will not cause detonation of the rocket motor.

FIGURE 1 M55 ROCKET PROPELLANT TEST

FIGURE 2 M55 ROCKET PROPELLANT TEST

6

FIGURE 3 M55 ROCKET PROPELLANT TEST

K-14

**FIGURE 4 M55 ROCKET PROPELLANT TEST**

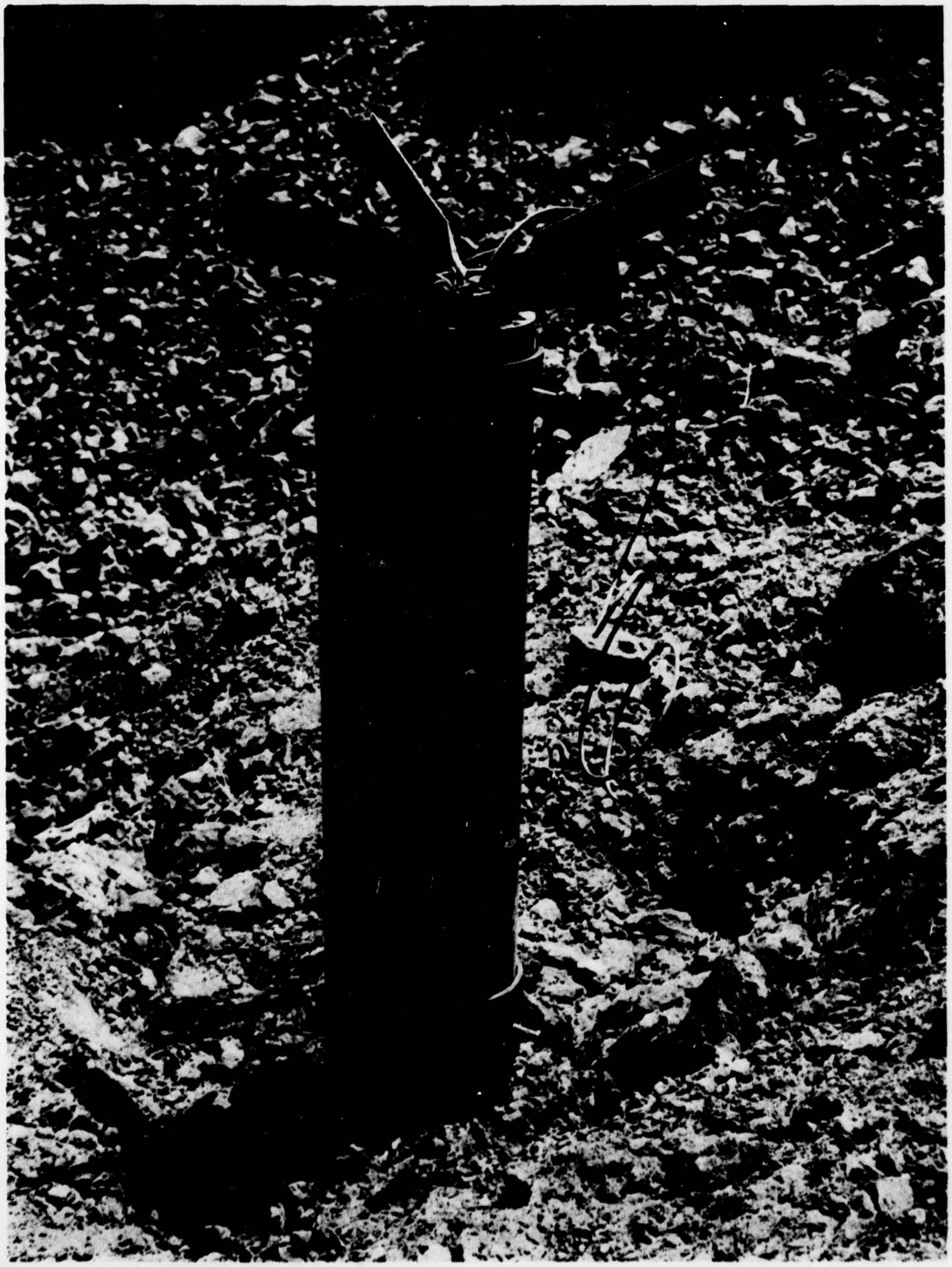


FIGURE 5 M55 ROCKET PROPELLANT TEST

K-16

SUMMARY TEST REPORT*

CAMDS 6-4

1. Name of Test: M61 Rocket Saw Test

2. Date: 23 Sept 1970

3. Test Objective: To ascertain what may happen in the event the No. 1 saw cut passes through the booster of the fuze rather than between the booster and M36 burster. See Figure 1.

4. Test Procedure: The location of the cut was adjusted three times during the first 16 tests as shown in Figure No. 2. The result of the first test is shown in Figure No. 3. Note that the saw blade passed through near the booster bottom, thus causing the metal bottom to be "Shaved" off as shown in the Figure. Figure No. 4 depicts typical results achieved during test 2 through 10. Note that in each case the saw cut through the booster cup and pellet. Typical results of tests 11 through 15 are depicted in Figure No. 5. As before, the saw passed through the booster cup and pellet. The tabulated data for the 15 tests is detailed as follows:

| Test No. | Cutting Time | Location of Cut | Remarks |
|---|---|---|---|
| 1 | 107 | 4 3/8 | |
| 2 | 35 | 4 5/16 | Readjusted cutting time and changed location of cut. |
| 3 | 34 | 4 5/16 | |
| 4 | 32 | 4 5/16 | |
| 5 | 30 | 4 5/16 | |
| 6 | 30 | 4 5/16 | |
| 7 | 30 | 4 5/16 | |
| 8 | 32 | 4 5/16 | |
| 9 | 31 | 4 5/16 | |

* A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

| Test No. | Cutting Time | Location of Cut | Remarks |
|---|---|---|---|
| 10 | 33 | 4 5/16 | |
| 11 | 33 | 4 1/4 | Changed location of cut. |
| 12 | 31 | 4 1/4 | |
| 13 | 30 | 4 1/4 | |
| 14 | 31 | 4 1/4 | |
| 15 | 27 | 4 1/4 | |

After completion of the first 15 tests it was decided to adjust the position of the saw so as to cut through the booster lead charge. In order to determine the exact position of the lead charge, three trial cuts were made during which the rockets position was varied in 1/16" increments. During the fourth test (No. 19), the saw blade passed through the lead charge as shown in Figure No. 6. Figure 7 and 8 depict other results achieved during tests 16 through 20. Tabulated data for the five tests is detailed as follows:

| Test No. | Cutting Time | Location of Cut | Remarks |
|---|---|---|---|
| 16 | * | 4 1/8 | (*-Time not recorded. **-IT was planned to repeat the location of the previous cut (No. 19), due to an error improper positioning of the rocked occurred.) |
| 17 | * | 4 1/16 | |
| 18 | * | 4 | |
| 19 | * | 3 5/16 | |
| 20 | * | ** | |

5. <u>Results</u>: All cuts were made without incident.

6. <u>Conclusion</u>: Sawing through the booster during demil operations of the M55 rocket on the Punch, Drain, and Saw Machine will not occur unless improper packaging of the rocket in the container, or improper positioning of the rocket has occurred. If sawing through the booster should occur, <u>it will not cause the</u> burster to detonate or burn.

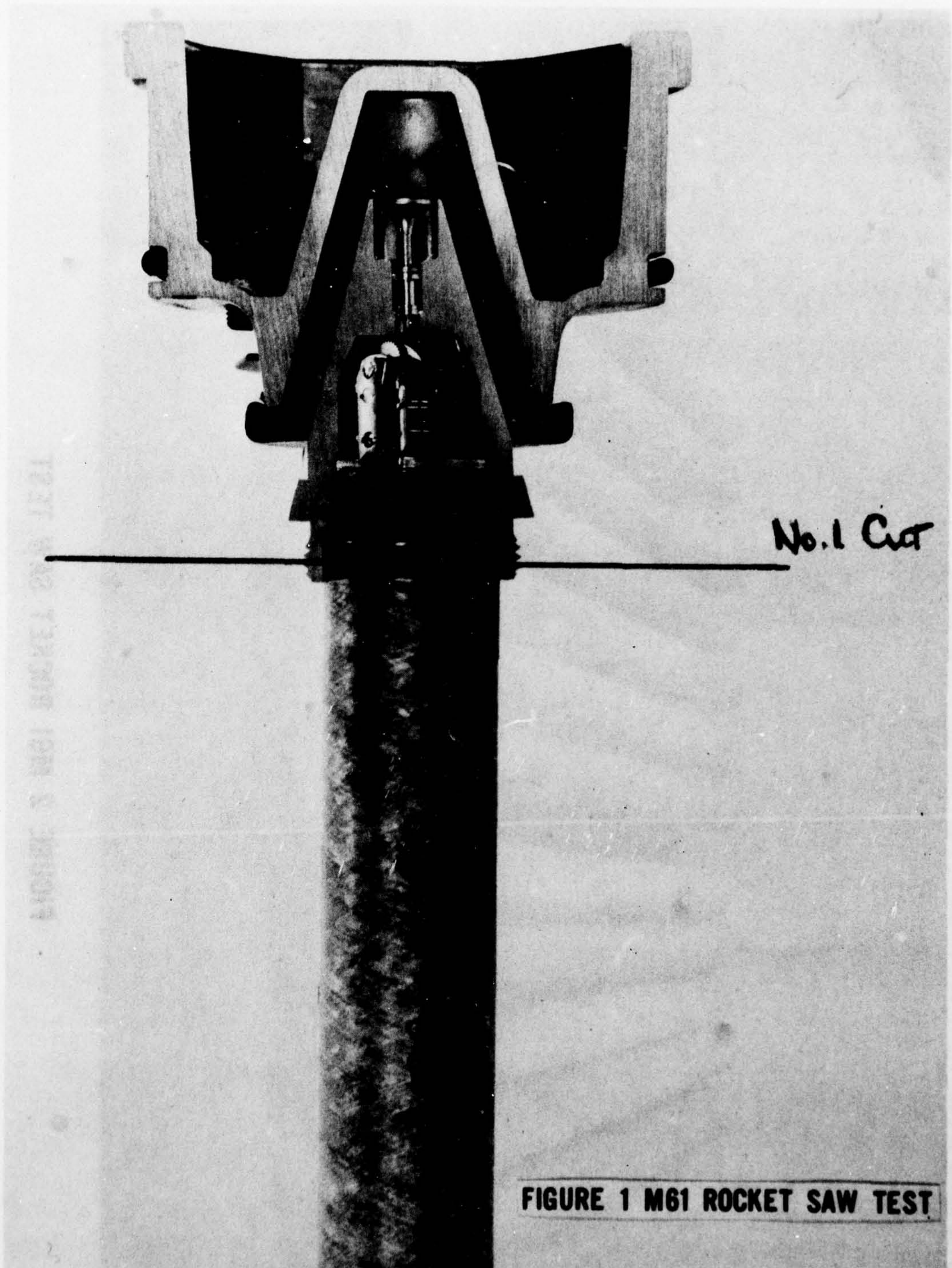



FIGURE 1 M61 ROCKET SAW TEST

5-19

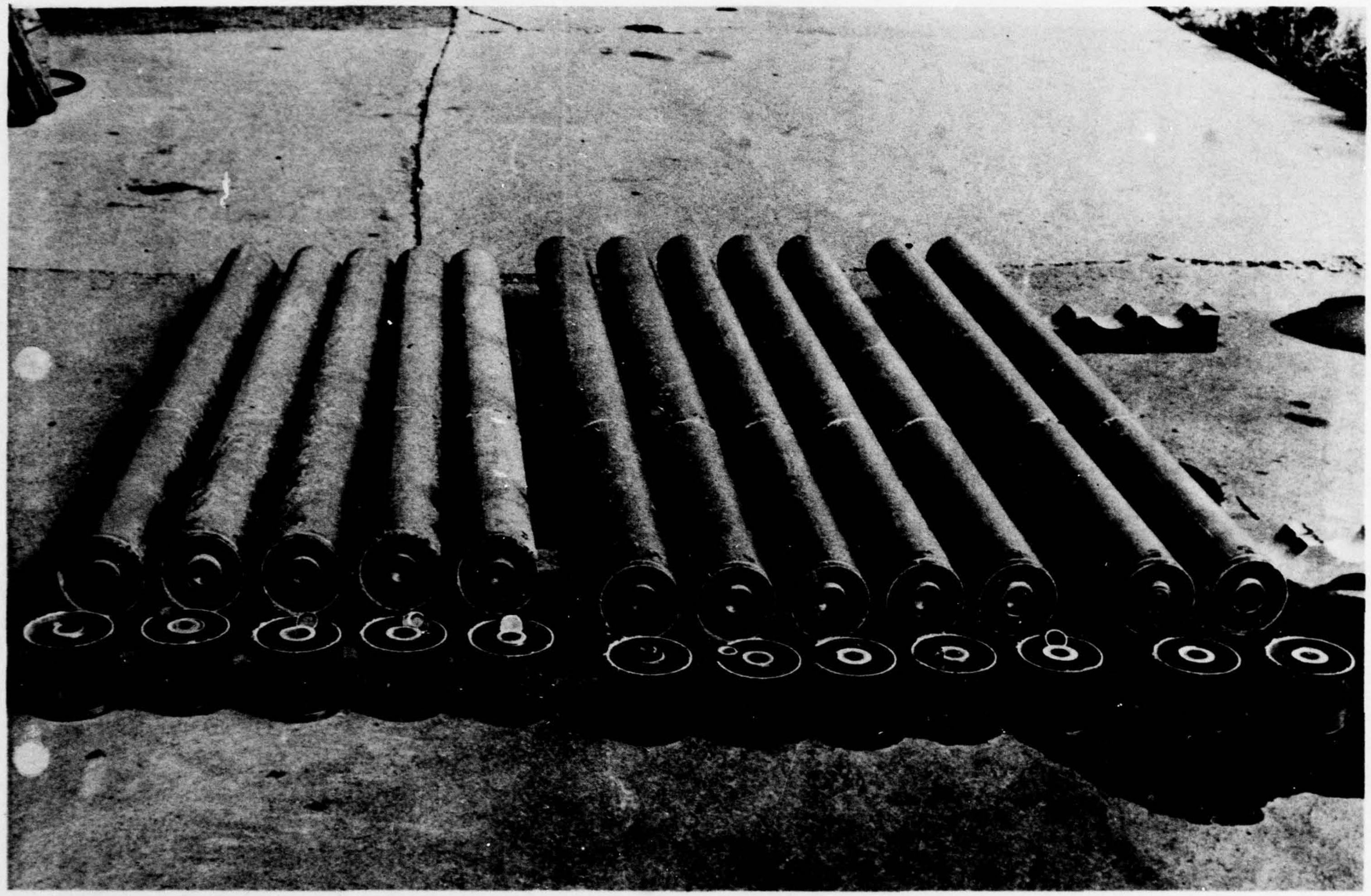


FIGURE 2 M61 ROCKET SAW TEST

12-21

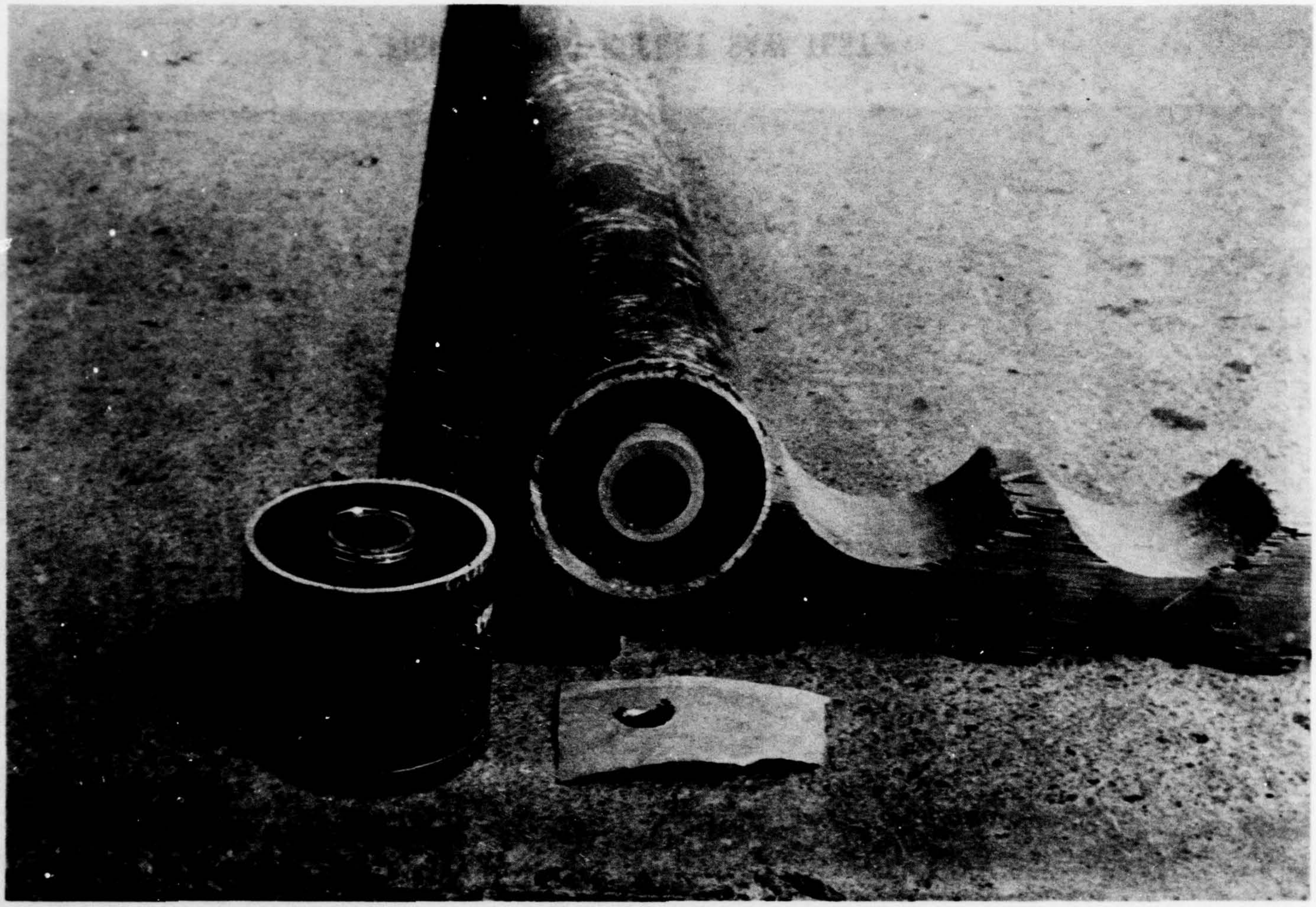


FIGURE 3 M61 ROCKET SAW TEST

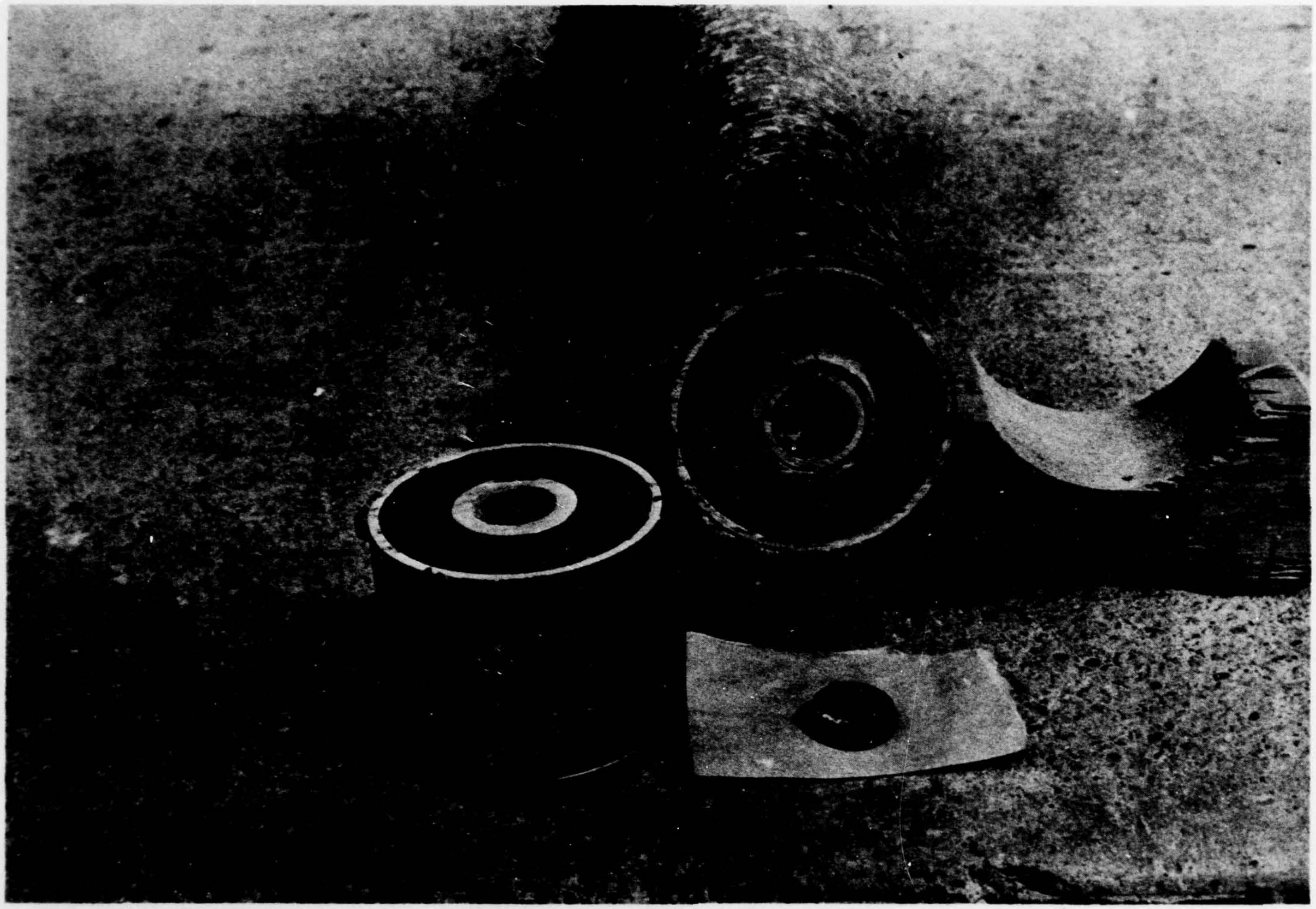


FIGURE 4 M61 ROCKET SAW TEST

15·22

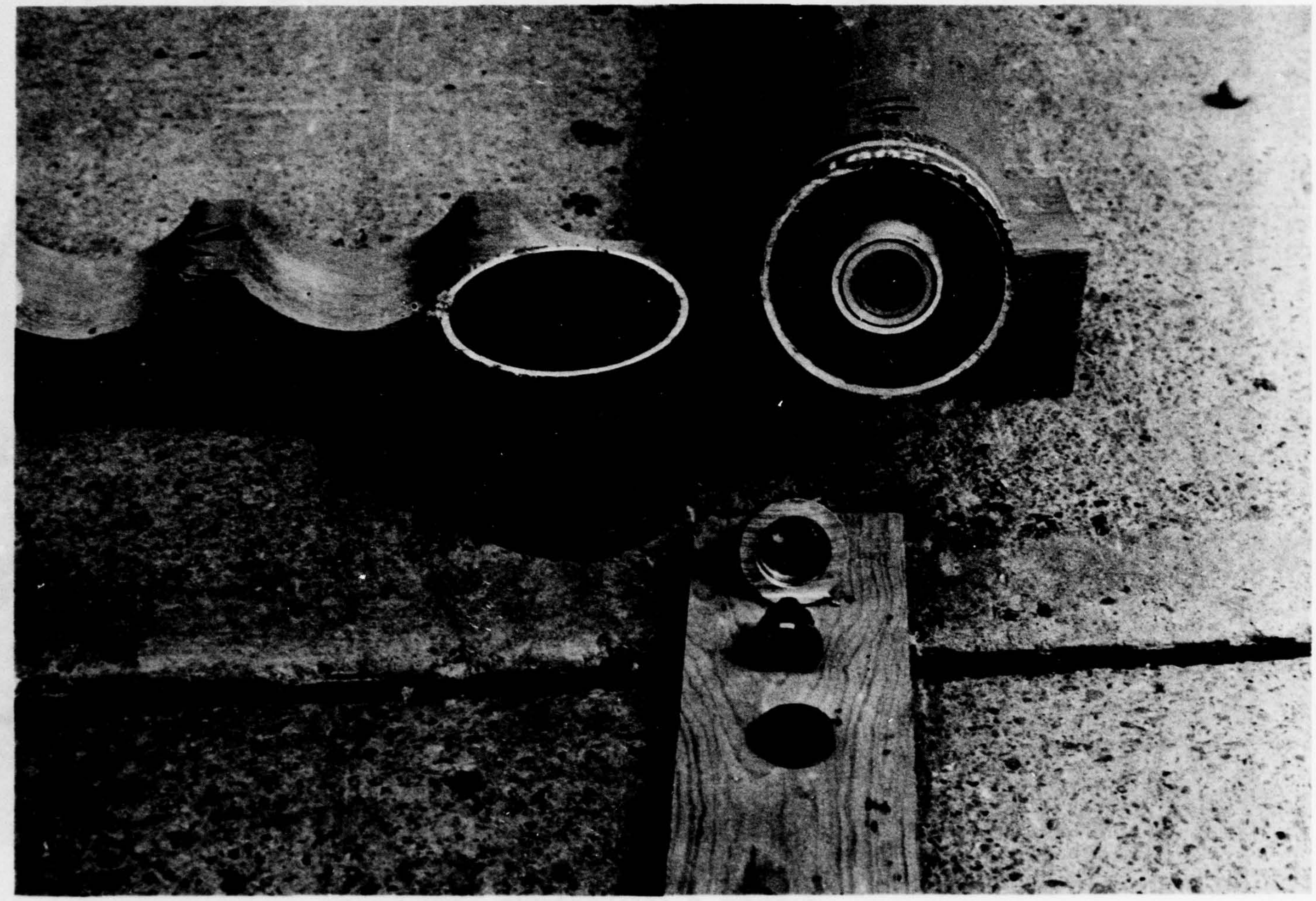


FIGURE 5 M61 ROCKET SAW TEST

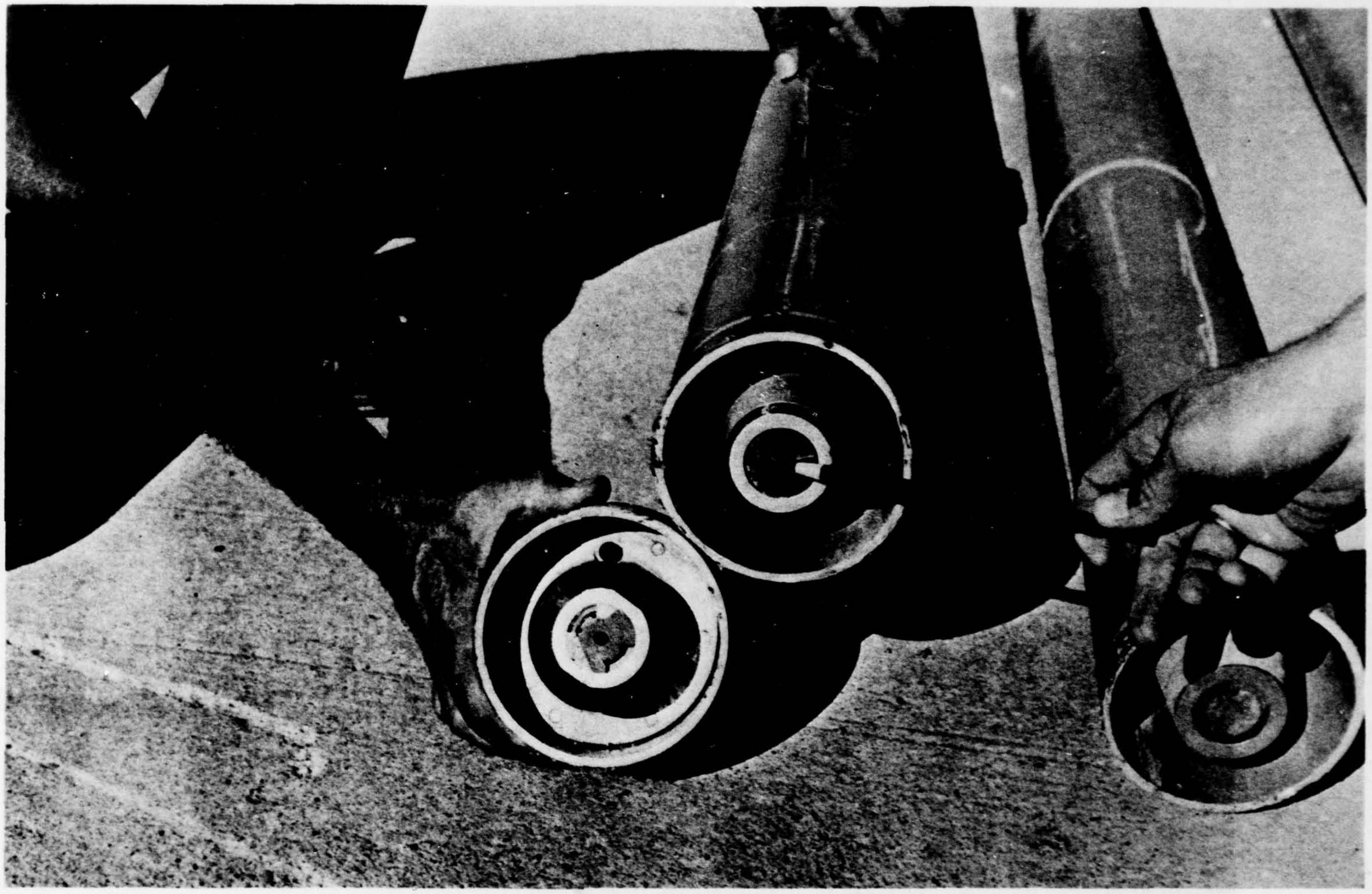


FIGURE 6 M61 ROCKET SAW TEST

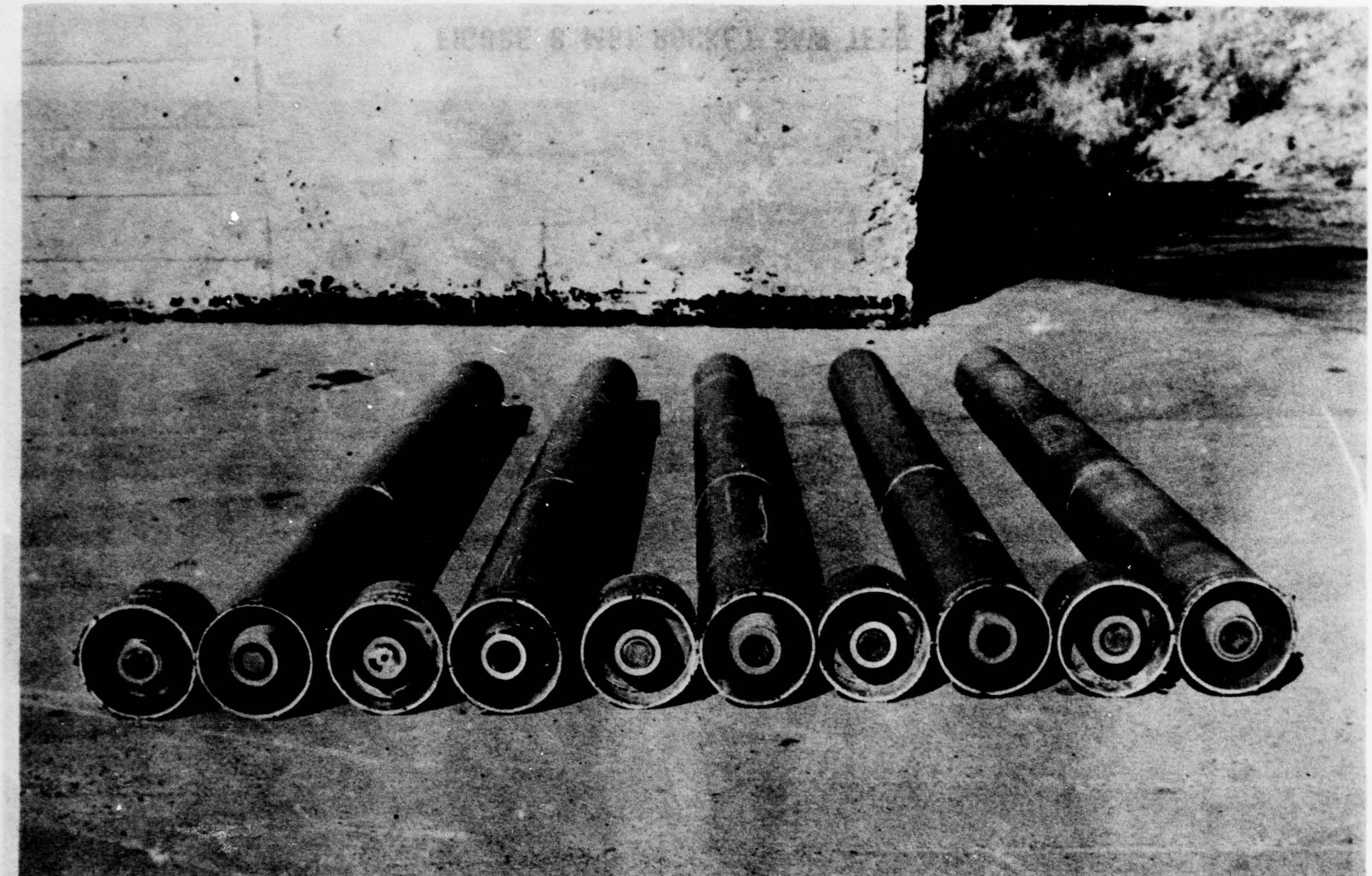


FIGURE 7 M61 ROCKET SAW TEST

FIGURE 8 M61 ROCKET SAW TEST

## TEST REPORT

## CAMDS 6-5

## COLD SAWING TEST SUMMARY*

## M61 ROCKET

Sawing tests on the 115mm M61 rocket were started in January 1970 using a Johnson/K-Line Model #378 milling quality (cold) saw. The use of this saw was based upon the expectation that the low blade speed (25 rpm) would alleviate the fire problems which had been experienced in past sawing of rocket motors using a conventional power hack saw.

All cold sawing of live rockets to date has been accomplished at the TEAD TV Site. The saw was located on the west side of the first barricade, and all sawing operations were monitored by closed-circuit TV. The TV monitor was installed in the personnel bunker located 150 ft. west of the first barricade.

The hydraulic work holding vise of the Model #378 saw machine was modified to accept the rocket in its fiberglass container. The clamping force for this vise is normally supplied from an air-over-oil booster which can generate a 1600 pound clamping force using a 100 psi air supply. Initial tests showed that a clamping force of approximately 3000 pounds was required when clamping any portion of the rocket motor, so the air-over-oil booster was replaced by an Enerpac Model #PA-130 booster pump to meet the higher requirement. This booster pump is capable of a 10,000 psi hydraulic output from 100 psi air input. A 5000 psi hydraulic gage was installed between the pump and the clamping vise to read the clamping pressure.

It was found that optimum clamping force for the warhead pieces was approximately 1200 pounds and approximately 3200 pounds for the motor pieces.

In addition to the vise modification, a fixture was fabricated which would restrain the rocket should a motor ignition occur during sawing. This fixture consisted of an aluminum tube bolted to the saw frame, into which the rocket was inserted for sawing. The saw itself was lagged to the existing concrete slab at the TV site.

The controls of the standard Model #378 were also modified and located remotely at the personnel bunker. The remote controls were:

Motor "On and Off" switch
Saw feed push button
Saw retract push button
Coolant pump "On and Off" switch

An existing switch to retract the blade automatically when a cut is finished was left on the saw "as is".

* A copy of the complete test reports are available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

The coolant system was modified so that a stream of coolant ran directly onto the side of the blade above the kerf. Coolant used was water with about 15% ethylene glycol added to prevent freezing.

Coolant is normally recirculated in the system supplied with the standard saw. This system was modified so that only fresh coolant was supplied to the blade and the used coolant (containing chips and explosive cuttings) was piped by gravity to a catch tank. This catch tank, in turn, was dumped periodically at the demolition area burning pits.

In April 1970, the cold saw was removed from its base and mounted on a special base inside a 4 ft. X 4 ft. X 8 ft. long tank. By filling the tank with coolant to the proper level, the rockets could be completely submerged during sawing, thereby simulating conditions to be encountered in the Rocket Demil Machine (RDM). The coolant pump and piping system was removed for this modification. All cold sawing done since this installation has been accomplished with the item submerged in either water or 10% sodium carbonate solution.

During the actual demil of the rocket using the RDM, the item will be sawed through at 6 different locations. Most of the rocket sawing done to date has been at these 6 locations; however, 20 rockets were purposely sawed through the booster cup to determine if the more sensitive tetryl in the booster would detonate should the saw be misaligned.

The complete record of rocket cold sawing to date is attached. This shows the blades used, location of cuts, number of cuts, and pertinent remarks.

It is apparent from the chart that cuts 4 and 5 will be the critical cuts. Care should be taken in these areas to select the best blades.

## SUMMARY

The table below summarizes the number of cuts made. The limited variations footnoted were caused by positioning of the rocket in the saw.

| Cut No. | LOCATION | No. of Times |
|---|---|---|
| 1 | Aft of fuze | 164* |
| 2 | Through M34 burster | 162 |
| 3 | Through M34 burster | 163** |
| 4 | Through propellant grain | 163 |
| 5 | Through propellant grain | 163 |
| 6 | Aft of propellant grain | 163*** |
| N/A | Through booster | 30 |



K-18

* - occasionally this cut topped the M36 burster.

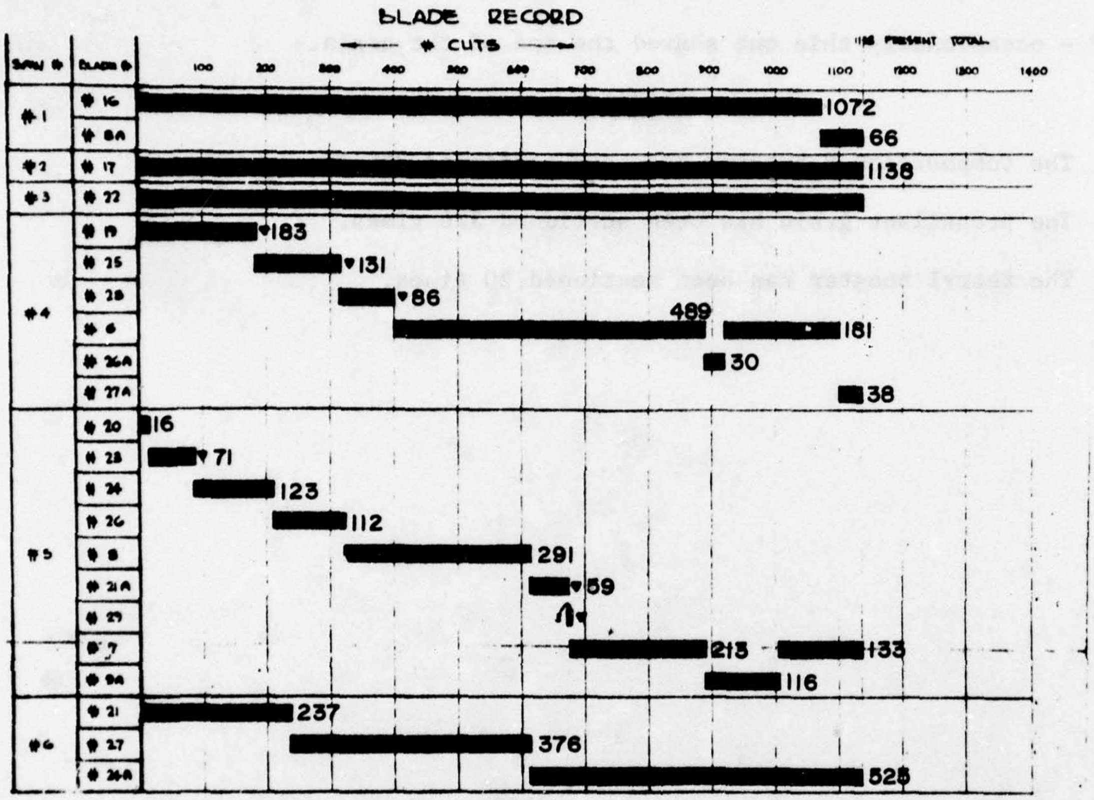
** - occasionally this cut missed the base of the M34 burster.

*** - occasionally this cut shaved the end of the grain.

## RESULTS

1. The Composition B burster has been sectioned 325 times.
2. The propellant grain has been sectioned 326 times.
3. The tetryl booster has been sectioned 20 times.

K-29




▼ INDICATES BLADE BROKE

# 16 - SIMONDS - 16" Φ - 140T
# 8A - RESHARPENED SIMONDS - 16" Φ 140T
# 17 - SIMONDS - 16" Φ - 140T
# 22 - SIMONDS - 16" Φ - 140T
# 19 - SIMONDS - 16" Φ - 140T
# 25 - SIMONDS - 16" Φ - 140T
# 28 - SIMONDS - 16" Φ - 140T
# 6 - K-LINK - 15¾" Φ - 150 T
# 26A - RESHARPENED SIMONDS - 16" Φ 140T
# 27A - RESHARPENED SIMONDS - 16" Φ 140T
# 20 - SIMONDS - 16" Φ - 140T

# 23 - SIMONDS - 16" Φ - 140 T
# 24 - SIMONDS - 16" Φ - 140 T
# 26 - SIMONDS - 16" Φ - 140 T
# 8 - SIMONDS - 16" Φ - 140 T
# 21A - RESHARPENED SIMONDS 16" Φ - 140 T
# 29 - MEYERS CARBIDE 16 Φ - 120T (EXPERIMENTAL)
# 7 - K-LINK 15¾" Φ 150 T
# 9A - RESHARPENED SIMONDS 16" Φ - 140 T
# 21 - SIMONDS - 16" Φ - 140 T
# 27 - SIMONDS - 16" Φ - 140 T 16" Φ - 140 T

SAW BLADE RECORD
PD & S MACHINE
25 APRIL 72
SK-T172-PDS-1

K-30

**CHART 1 COLD SAWING TEST SUMMARY**

SUMMARY TEST REPORT*

1. Name of Test: Sludge Generation Test

2. Date: 15 Sept 1971

3. Test Objective: To generate sludge for testing at Edgewood Arsenal. A secondary objective was to determine sludge accumulation rate in the Rocket Demil Machine (RDM).

4. Test Procedures:

a. A total of twenty-seven live M-61 rockets were processed through the RDM. These items had been previously drained of their simulant fill and flushed with acetone and water.

b. Prior to the start of these tests, the RDM was thoroughly cleaned and the submergence tank was drained and cleaned of all cuttings and foreign material.

c. The tank was filled with 55.1 cu. ft. of clean water.

d. An item-by-item account of the sawing operation is as follows:

(1) Rocket #1.
All cuts were accomplished. Some difficulty was experienced in withdrawing the segregator tray. It appeared that the difficulty was a binding within the Tolmatic cylinder. The tray was detached from the Tolmatic cable and the cylinder exercised for about ten cycles until it appeared free. The tray was reinstalled and no further difficulty occurred. Saw #1 required 25 seconds to cut through.

(2) Rocket #2.
All cuts were accomplished. The rocket positioning stop in the RDM was moved out 1/16th inch to locate the cuts closer to the rocket nose. The #3 saw time was 30 seconds.

(3) Rocket #3.
All cuts were accomplished. The rocket positioning stop was again moved out 1/16th inch. The #4 saw time was 40 seconds.

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

(4) Rocket #4.

The #6 saw cut only 3/4 of the way through the rocket. This was caused by too slow a feed rate on this saw. The flow control was opened up slightly to correct this condition. All other saw cuts were accomplished.

(5) Rocket #5.

All cuts were accomplished, and cut locations were good.

(6) Rocket #6.

The #6 saw again only cut about half way through the item. The flow control was again opened slightly to speed it up. This flow control is faulty and will be changed as soon as a replacement arrives (has been ordered). All other cuts were accomplished. The #5 saw time was 50 seconds.

(7) Rocket #7.

All cuts were accomplished. The #6 saw, although it completed, was too slow, and its' flow control was again opened slightly. The #1 saw time was 25 seconds.

(8) Rocket #8.

The #5 cut did not complete because the rocket motor turned inside the fiberglass tube. Clamping pressure was raised from 400 psi to 420 psi to achieve tighter clamping. No additional problems of this nature occurred. All other cuts were accomplished. Saw #6 was not timed, but was obviously too fast. Saw #3 time was 40 seconds.

(9) Rocket #9.

All cuts were accomplished.

(10) Rocket #10.

All cuts were accomplished. The #6 saw was obviously too fast, and the flow control was closed down slightly.

(11) Rocket #11.

All cuts were accomplished. The #6 saw time was 25 seconds.

(12) Rocket #12.

All cuts were accomplished. Cut #3 did not quite open up the bottom of the burster well.

(13) Rocket #13.

The #6 cut did not complete (3/4 through) again due to flow control adjustment. The flow control was opened up again. All other cuts completed.

(14) Rocket #14.

The #6 saw again did not complete and the flow control was again opened up slightly. All other cuts completed. The #1 saw time was 20 seconds and the #3 saw time was 22 seconds.

(15) Rocket #15.

All cuts were accomplished. The #5 saw blade jammed in the cut after completion and kicked out its' breaker. This appeared to be due to resinator rods binding in the kerf. The #4 saw time was 35 seconds, about right. The #6 saw time was 10 seconds, too fast.

(16) Rocket #16.

All cuts were accomplished. The clamp/staker did not penetrate the fiberglass tube. Examination of several tubes showed a difference in material and this particular one was very hard. Since the steel burster tube was not staked, it rotated somewhat during cutting, but the cut was still made. All cut locations were good. The #1 cut required 35 seconds, the #4 cut required 53 seconds, the #5 cut required 40 seconds, and the #6 cut was again too fast.

(17) Rocket #17.

All cuts were accomplished. The blade on #5 saw showed some wear and was removed. It was replaced with a new blade.

(18) Rocket #18.

All cuts were accomplished. Again a hard tube wass encountered and the clamp/stacker did not penetrate. System pressure for this circuit was increased from 200 psi to 220 psi in an effort to achieve penetration. All cut locations were good. The #1 saw time was 23 seconds, and the #6 saw time was 25 seconds. Total cycle time was 5 minutes, 40 seconds.

(19) Rocket #19.

All cuts were accomplished. The clamp/staker did not penetrate due to another hard tube. System pressure was increased to 250 psi. The #6 saw time was 25 seconds.

(20) Rocket #20.

All cuts were accomplished. The rocket did not feed into the punch station on the first attempt. Upon restart it fed satisfactorily. The trouble appeared to be jamming at the first item roller. The #3 saw time was 32 seconds.

(21) Rocket #21.

All cuts were accomplished and locations were good. System pressure on the clamp/staker cylinders was cut back to 200 psi. Saw cut #4 required 52 seconds and cut #6 required 21 seconds.

(22) Rocket #22.

As the punches in the punch and drain section withdrew, both punches stuck in their bushings and broke the heads off the bushing retainer bolts. After clearing the rocket from this station, the punches and bushings were removed. Since punch and drain were not a part of this test, it was decided to process the remaining rockets with the punches removed. The rocket was again started through the machine, and all cuts were accomplished. All cut locations were good, and the clamp/staker performed satisfactorily.

(23) Rocket #23.
All cuts were accomplished and cut locations were good.

(24) Rocket #24.
All cuts were accomplished. The clamp/staker again failed to penetrate due to a hard fiberglass tube.

(25) Rocket #25.
All cuts were accomplished. The short piece of propellant jammed behind the push-off plate in the segregator.

(26) Rocket #26.
All cuts were accomplished and locations were good.

(27) All cuts were accomplished and clamp/staker performed satisfactorily.

e. Prior to draining the submergence tank, the filter bags were wet with water and weighed as follows:
a. (1) - 100 micron bag - 303 gms
b. (2) - 100 micron bag - 300 gms
c. (3) - 25 micron bag - 362 gms
d. (4) - 10 micron bag - 355 gms

f. After draining about 50% of the tank contents, the first 100 micron bag was about 2/3 full of solids and flow through it was very restricted, so it was replaced with a second 100 micron bag. The other two bags were not changed during the test. After the complete tank volume had been drained through the filter bags, the bag contents and filtrate were examined. The findings are as follows:

5. Test Results:

a. The contents of the two 100 micron bags appeared to be propellant, Comp B, aluminum, steel, and fiberglass chips along with some fiberglass fuzz. Bag #1 weighed (wet) 8 lb - 2 3/4 oz: Bag #2 weighed (wet) 4 lb - 8 ozs.

b. The 25 micron bag appeared to be lined completely with a gray fiberglass fuzz. Virtually no solids were captured. This bag weighed 1 lb - 1 1/8 oz. (wet).

c. The 10 micron bag also was covered inside with what appeared to be a gray fuzz. No solids were apparent. This bag weighed 15 1/2 oz. (wet).

d. Fifty gallons of filtrate were collected. About 1/3 was collected at the start of the run, 1/3 during the middle of the run, and 1/3 at the end of the run. After the total amount was collected it was examined. It appeared to be mostly clear and contained no visible solids. It had a slight, yellow-brown cast and this slight coloration was

more pronounced near the surface than at depth. This liquid was collected in two 30 gallon plastic drums before being transferred to a 55 gallon stainless steel shipping drum.

e. All filter bags with their sludge contents were individually packaged in plastic bags along with identification tags. These were in turn sealed in a steel ammunition box for shipment to Edgewood Arsenal along with the 50 gallon drums of filtrate.

## SUMMARY TEST REPORT*

## CAMDS 6-7

1. Name of Test: Explosive Accumulation Test of Segregator (PDS Machine).

2. Date: (Not dated.)

3. Test Objectives: To determine the frequency of operation shutdown required to remove propellant explosive and trash buildup which may create explosive hazard or malfunction of segregator moving parts.

4. Test Procedure:

The segregator was partially disassembled to allow complete removal and cleaning of tray area of saw chips (fiberglass, aluminum, propellant, explosive, felt and resonator rod pieces).

The segregator was then reassembled and a total of 51 each M61 live, simulant filled rockets were processed through the machine (punched, drained, sawed, and segregated).

The segregator was then again partially disassembled and thoroughly cleaned. All residue was collected, weighed, and measured.

5. Results:

The total residue collected weighed 269.5 grams, and the total volume collected was 31.9 cubic inches. NOTE: This residue was weighed and measured in dry form (not saturated with water).

6. Conclusions/Recommendations: The information generated above will be used to determine operation shut down frequency.

* A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

SUMMARY TEST REPORT*
CAMDS 6-8

1. <u>Name of Test</u>: M61 Rocket Casing Burn Test

2. <u>Date</u>: 2 May 1972

3. <u>Test Objectives</u>: To determine if the fiberglass casing, as cut with the Rocket Demil Machine (RDM), would burn adequately without the additional heat provided by propellant and burster combustion.

4. <u>Test Procedures</u>:

a. Eight M61 rockets were burned in the APE 1236 deactivation furnace. The sections were fed at specified intervals, one complete rocket each two (2) minutes.

| Section | Time | |
|---|---|---|
| Tail Fin and Fuze End Cap | 0 Sec | |
| Motor | 0 + 11 Sec | |
| Motor | 0 + 22 Sec | 2 min. each rocket |
| Burster | 0 + 66 Sec | |
| Burster | 0 + 96 Sec | |

b. Furnace Conditions were as follows:

Retort speed: 1 RPM
Burner end temperature at start: 1160-1180°F
Stack end temperature at start: 300-320°F
Controller set point: 1160°F
No flapper valve in feed chute and no seals on rotary retort joints.

c. After the cases were burned, the bare propellant, fuze, and burster tube sections were burned.

5. <u>Results</u>:

a. During the casing burn, the following conditions were observed:

Burner end temperature: Climbed to a peak of 1470°F by end of test.
Stack end temperature: Climbed to a peak of 420°F by end to test.
Heavy gray plume from stack throughout burn.

b. The burning of the bare propellant, fuze and burster tube section resulted in the following observations:

* A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

Burner end temperature: 1420 F peak
Stack end temperature: 1120 F peak

During this burn, four puffs (assumed to be CO ignition) occurred. During burning of some propellant sections, a heavy white plume was generated; however, other propellant sections produced a heavy white plume mixed with a yellow-yellow brown plume. This plume occasionally was dark brown. Flame was visible at stack outlet during motor burn.

6. <u>Conclusions and Recommendations</u>: The fiberglass casing, as cut with the RDM, will burn adequately without the additional heat provided by propellant and burster combustion.

SUMMARY TEST REPORT*
CAMDS 6-9

1. Name of Test: Propellant Ignition Test

2. Date: 18 August 1972

3. Test Objectives: To determine if submerging a rocket motor in water will prevent ignition and burning of the rocket propellant.

4. Test Procedure:

The rocket motor section was separated from the warhead section on four M61 rockets. Two of the rocket motor sections were tested in an "as is" condition (uncut). The other two rocket motor sections were placed into the Rocket Demil Machine (RDM) and cut approximately halfway through in three different places. They were then removed from the RDM and were carefully inspected to assure that the two igniter lead wires were not cut or damaged.

The rocket motor section was positioned and secured inside a 55 gallon drum. The nozzle plugs were removed, the drum and rocket was filled with water, and the test leads were connected to the leads of the rocket motor. Ignition of the rocket motor was accomplished by means of a blasting machine, 10 cap capacity, from a remote control bunker.

5. Results:

Rocket No. 1 - The igniter fired resulting in the rocket motor casing and propellant being propelled up and out of the drum. The motor casing was expelled to a height of approximately 30 feet into the air and fell back onto the ground approximately 20 feet away from the drum. The propellant fell back into the drum. The adjustable jaws failed to hold the rocket motor section tight enough to retain it within the drum. To eliminate a recurrence of this on the next 3 test phases, one half of the adjustable jaw assembly was removed from the drum, and the end surfaces were ground off to provide for more holding ability.

Rocket No. 2 - The igniter fired and the propellant started to burn and continued to burn for apporximately 6 1/2 minutes, then extinguished. The rocket motor was removed from the drum and disassembled. Upon inspection of the propellant, it was observed that approximately 8" of one of the three "Web" sections of the propellant burned.

Rocket No. 3 - The igniter fired but the propellant failed to ignite and burn.

Rocket No. 4 - Same as that of Rocket No. 3. No ignition or burn of the propellant.

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

6. Conclusions: Submerging the rocket motors in water does have a direct effect on the function of the rocket components. The test indicated that if the propellant does ignite, the burning is retarded extensively by the liquid in which the rocket is submerged.

## SUMMARY TEST REPORT*
## CAMDS 6-10

1. Name of Test: Drain Test of M61 rockets.

2. Date: 31 Oct 1972

3. Test Objectives: To determine efficiency of draining rockets by applying air pressure.

4. Test Procedure: Two M61 rockets were prepared for the test by draining them completly and filling them with a measured quantity of water (4,000 milliliters). After filling, a standard tire valve was installed in the rocket body and a 70 psi air supply was applied to the agent cavity. Both rockets were then processed normally through the punch and drain station of the Rocket Demil Machine. The quantity of water from each rocket was then measured.

5. Results: The measurements were as follows:

| | | |
|---|---|---|
| Rocket #1, | 3,775 Milliliters | (94.4%) |
| Rocket #2, | 3,815 Milliliters | (95.5%) |

6. Conclusions: The rocket can be successfully drained with the application of pressure.

K-42

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

SUMMARY TEST REPORT*
CAMDS 6-11

1. Name of Test: Punch and drain tests on internally pressurized rockets.

2. Date: 9 Nov 1972

3. Test Objectives: To determine if abnormally high internal pressure in M55 rockets will adversely effect the punching operation on the Rocket Demil Machine (RDM).

4. Test Procedures:

a. Ten each M61 pressurized, simulant filled, inert rockets were processed through the punch station of the RDM during the period 22 Sept 1972 through 2 Oct 1972.

b. The ten rockets were prepared for test by drilling and tapping a 1/4" diameter hole through the side wall of the warhead at the extreme nose end. A standard tire valve was screwed into this tapped hole and air pressure was introduced to the agent cavity through this valve. The valve was installed in a manner so it projected only slightly beyond the rocket diameter thereby allowing the rocket with valve installed to be inserted into the fiber glass container. The rockets were pressurized at 70 to 85 psi.

5. Results: All of the pressurized rockets were visually observed during the punch and drain operations. No operational difficulties were encountered and no detectable differences in punching or draining were noted.

6. Conclusions: Abnormally high internal pressure in M55 rockets will not adversely effect the punching operation.

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

SUMMARY TEST REPORT*
CAMDS 6-12

1. Name of Test: Maintenance of Rocket Demil Machine wearing rubber.

2. Date: 26 June 1974

3. Test Objectives: To determine if minor adjustments, replacement of saw blades and warhead punches, can be performed wearing level A protective clothing.

4. Test Procedure:

a. Remove and replace saw blades: One operator on each side of the machine attached plastic coated vise-grip pliers 180° apart on outer edge of the saw blade. Operator #1 loosened the arbor nut with a 1/2" drive 7/8" socket, and then removed the nut and arbor washer. Both operators then worked the blade off the arbor with the pliers. The pliers were then placed on the replacement blade and the blade worked into position on the arbor by both operators and the washer and nut are reinstalled by hand and tightened with the wrench. (At no time was the blade handled with the gloved hand: pliers were used to prevent piercing of glove fingers with saw teeth.)

b. Remove and replace warhead punch: Loosen the locking allen screw, remove punch. Use caution not to cut gloves on the punch point. Reinstall and adjust the new punch and lock with an allen wrench.

c. Adjust flow of water onto discharge tray: Manually adjust the flow control valve.

5. Results: No exceptional problems occured except reduced angle of vision and difficulty in handling small allen wrenches, required to loosen and tighten the allen screws on the punches and the flow controls. Care must be taken to avoid dropping wrenches into the caustic tank.

6. Conclusions/Recommendations: If it becomes necessary for the operator to make the above adjustment, it is possible in rubber. A preventative maintenance inspection prior to each shift start up shall reduce, if not eliminate, any requirement to perform a majority of the maintenance tasks during normal production operations.

The following recommendations will also help to reduce possible problems:

Install a lanyard, with allen wrench attached, adjacent to each of the 6 saw feed flow control valves. Provide a 3' high platform for the operators to stand on while adjusting saw feed flow control valves.

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

## TABLE OF CONTENTS

### INCLOSURE NO. 11 SECTION 2
### PROJECTILE DEMIL MACHINE TEST SUMMARIES


| | Page Number |
|---|---|
| BURSTER SAW TEST | 1 |
| DELTA-P REMOVAL OF STUCK INERT BURSTERS | 2 |
| DELTA-P REMOVAL OF STUCK LIVE BURSTERS | 4 |
| DELTA-P TEST ON LIVE PROJECTILES | 5 |

SUMMARY TEST REPORT*

CAMDS 15-1

1. Name of Test. Burster Saw Test.

2. Date. 13 March 1972.

3. Test Objective. To determine if various projectile bursters could be safely sawed into sections small enough to process through a deactivation furnace. To determine the time required to saw the bursters.

4. Test Procedures. The bursters were ridgidly held using a pneumatic vice with 2000 pounds force and were cut with a 14-inch diameter, 180-tooth, 1/8 inch-thick radial saw operating at 25 RPM. Water coolant was used to cool the blade.

5. Test Results. 900 cuts were made without incident on various bursters as shown in the following chart:

| TYPE OF BURSTER | TYPE OF CASE | EXPLOSIVE | AVG. TIME REQUIRED TO SAW | NUMBER OF ITEMS CUT | AVG. WASTE PER CUT IN GRAMS |
|---|---|---|---|---|---|
| M 83 | Aluminum | Comp B4 | 20 sec. | 234 | 18 |
| M 71 | Aluminum | Comp B4 | 13 sec. | 161 | 11.5 |
| M 40A1 | Steel | Comp B4 | 9 sec. | 153 | 8.5 |
| M 5 | Aluminum | Tetrytol | 3.5 sec. | 152 | 1.4 |
| M 5 | Steel | Tetrytol | 3.5 sec. | 200 | 1.5 |

6. Conclusions. Burster sawing is a safe concept to use in the design of a projectile demilitarization machine.

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

K-46

SUMMARY TEST REPORT*

CAMDS 15-2

1. Name of Test. Delta-P Removal of Stuck Inert Bursters.

2. Date. December 1973 - January 1974.

3. Test Objectives. To determine if the Delta-P principle could be used to remove stuck bursters from projectiles. To determine the optimum air pressure and operating sequences to utilize with the Delta-P extractor.

4. Test Procedures. The burster wells of thirty 155mm projectiles were painted internally with normal and excessive quantities of paint. Inert simulated bursters were installed in the projectiles at varying time intervals (immediately, 15 min., 30 min.) after the paint was applied. The nose closure plugs were installed and 15 projectiles were stored in a vertical position, the other 15 in a horizontal position. The nose closure plugs were then removed and attempts were made to remove the bursters with the Delta-P extractor at various air pressures and operating modes.

The bursters were re-installed in the projectiles without nose closure plugs. The projectles were allowed to dry for a six-week period then burster removal was tested again.

5. Test Results.

a. One burster on the first test phase and four bursters on the second test phase could not be removed with the Delta-P extractor. All had excessive (1 1/2 to 2 inches) amounts of paint in the burster wells.

b. Bursters were pulled on the first attempt more often if the air pressure was applied before extending the pull tube against the burster.

c. No improvement occurred raising the air pressure above 120 psi.

d. Repeated operations or jogging the pull tube back and forth against the burster can break loose some stuck bursters.

6. Conclusions.

a. The Delta-P principle is still the best known method to remove bursters but an alternate method to remove stuck bursters must be developed.

* A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

b. The air pressure should be applied after the Delta-P head has been extended but before the burster pull tube is extended.

c. Operational controls should permit recycling of Delta-P extractor if the burster does not pull on first attempt.

SUMMARY TEST REPORT*

CAMDS 15-3

1. Name of Test. Delta-P Removel of Stuck Live Bursters.

2. Date. April 1974.

3. Test Objective. To determine if it is safe to use the Delta-P principle to remove live bursters.

4. Test Procedure. The burster wells on eighteen 155mm projectiles were painted with black acid-proof paint. After 15 minutes drying time, live M6 bursters were installed in the burster wells. The nose closure plugs were left off so the paint would dry faster. The projectiles were allowed to dry for 7 days. Half of the projectiles were dried laying horizontal, the other half laying vertical. A Delta-P extractor was then used to pull the bursters. The air was turned on before the pull tube was extended against the burster.

5. Test Results. All the bursters were pulled without incident.

6. Conclusions. It is safe to use the Delta-P principle to remove stuck bursters from projectiles.

* A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

SUMMARY TEST REPORT*

CAMDS 15-4

1. Name of Test. Delta-P Test on Live Projectiles.

2. Date. 4 September 1974.

3. Test Objective. To confirm the results of previous simulated stuck burster removal tests by using the Delta-P extractor to remove the stuck bursters from three live 155mm, mustard-filled, M104 Projectiles that had been located during a surveillance sampling check in 1973.

4. Test Procedures. The Delta-P extractor was used with an air pressure setting of 100 psi.

5. Test Results. The Delta-P extractor removed the bursters from two of the projectiles on the first try. The third projectile container appeared contaminated so no attempt was made to remove the burster.

6. Conclusions. The Delta-P principle is the best concept to date for removal of bursters from projectiles.

K-50

* A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

## TABLE OF CONTENTS

**INCLOSURE NO.11 SECTION 3**

**PROJECTILE PULL AND DRAIN MACHINE TESTS**

**AGENT DRAIN AND DECONTAMINATION TEST**

**AGENT DRAIN AND RINSE TEST**

**SIMULANT AGENT DRAIN TESTS**

**CAMDS TEST SUMMARY**

**PDR AGENT DRAIN &**
**DECONTAMINATION TEST**

**PDR-ST-HD(S), GB(S), VX(S), EA(5032)-1-1**

**TEST NO. CAMDS 18-1**

**May 1973**

| Submitted By: | Reviewed By: |
|---|---|
| DONALD L. WALKER<br>Electronics Technician | JOHN K. BARTEL<br>Chief, Engr Office |
| ARTHUR L. GENOBLE<br>Chemical Engr | JOHN T. MASON III<br>MAJ, CmlC<br>Chief, Opr Office |

Approved By:

CHARLES BARONIAN
CAMDS Project Manager

## TABLE OF CONTENTS


| | Page |
|---|---|
| Introduction | 1 |
| Objectives/Determinations | 1 |
| Narrative Run Description | 2 |
| Evaluation | 7 |
| Conclusions/Recommendations | 9 |
| Appendicies | |
| Data Sheets | |
| Diagrams/Sketches | |
| Distribution List | |


K-53

## Introduction

These tests provided information on the times required to perform various functions of the Drain Station & the Rinse Station of the Pull, Drain & Rinse (PDR) machine. They provided data on the performance and reliability of the individual components specified in the original design, including the liquid level sensors, pressure switches, vacuum pump, flow sensors and totallizer, and valve actuators.

## Objectives/Determinations

1. To determine the times required to drain 105mm, 155mm, and 8 inch munitions filled with VX, GB and HD simulants as a function of the amount of vacuum utilized.

2. To determine the time required to fill and drain the three munitions with water, thus evaluating the Rinse Station concept.

3. To chose a degree of vacuum such that the total cycle time will not exceed the time allotted for either the drain or rinse operation.

4. To measure the amount of simulant remaining in the munition after the draining operation thereby evaluating the effectiveness of the original design.

Run Description

A. The first series of tests, performed on the Agent Drain System (see Fig 1), were to determine:

1. Time required to evacuate the surge tank (primary vacuum source for liquid transfer) to the following levels below atmospheric pressure.

a. 6 in Hg

b. 8 in Hg

c. 10 in Hg

2. Amount of vacuum lost over a period of 10 minutes at each vacuum level. (This tested the fittings and surge tank.) These times are recorded on Data Sheet 1.

3. The repeatability and reliability of the vacuum switch and vacuum pump.

4. The operation performance of the control valves and actuators.

Simulants were used for all of these tests. They are listed in Table 1. The test munitions were placed on a stand 4 feet from the floor to simulate the height of the PDR conveyor. Each munition was then filled with a volume of simulant equal to the volume of agent one at a time and drained using a sequential operational system. A head, designed for draining purposes, along with a drain tube was positioned on the munitions. The sequential operation consisted of:

1. Evacuation of the surge tank to a pre-determined vacuum.

2. Closing of the valves to the vacuum pump, opening the valve from the surge tank to the separator tank, and applying the vacuum to the munition.

3. Draining the simulant into the separator tank.

4. Completing the cycle when the munition was empty, as determined by the vacuum switch signalling the system's return to atmospheric pressure.

5. Emptying the simulant from the separator tank to the container used for holding the simulant.

6. Refilling the munition and preparing the system for the next cycle.

The recorded times for this operation appears in Data Sheets 2, 3 & 4 for the three munitions. All times were duplicated after the set-up and

the procedure for each test had been checked for maximum operational performance. All times have been broken down into three segments for clarification of each part of the cycle. The first figure represents the time required to evacuate the surge tank. The second time is that time needed to drain the munition. The last time is the time needed for the drain line and separator tank to return to atmospheric pressure. During the last period, there was some "bubbling" in the drain line as the last of the simulant was drawn into the separator tank. These tests satisfied our first determination.

Run Description

B. The second series of tests were run with the system modified to sense the emptiness of munition and drain tube by means of liquid level sensors rather than a vacuum switch as was previously used. This modification was made because of the possibility that a leak could occur in the vacuum lines, giving a false indication that the munition was drained. For a comparison in drain times, the 155mm round was used along with a glycerin solution, to simulate VX at 40°F. The results of these tests are recorded on Data Sheet 5.

K-57

Run Description

C. The third series of tests involved the Rinse Station concept (see Fig 2). This station fills the munition with decon and subsequently drains it. The hardware involved is similar in design to that of the Drain Station, however, the Drain and Rinse Stations are separate and distinct stations. For these tests water was used as the decon simulant. The operations of the Rinse Station are as follows:

1. Simultaneously evacuate the surge tank to a pre-determined vacuum and fill the munition with liquid utilizing a pump.

2. Close the valves to the vacuum pump.

3. Sense the munition full of water using a level sensor and shut off the fill pump.

4. Apply vacuum to the munition and drain the water into the separator tank.

5. Sense the munition empty using liquid level sensors. Cycle complete.

The resultant times for these tests are shown on Data Sheet 6. These series of tests satisfied the second determination.

K-59

Run Description

D. The final series of tests were run to measure the amount of simulant left in the munitions (105, 155 and 8 inch) after draining. This data is necessary in determining if there is a need for the rinse station. The Metal Parts Furnace will be required to accommodate the round with the remaining agent, should it be decided to eliminate the rinse station.

These tests were performed using the worst conditions that would exist. Using VX simulant at 40°F and GB simulant at 40°F each of the three rounds were filled and drained using the same method as outlined in A above. The remaining simulant was extracted from the round by means of a modified hypodermic syringe and measured. The results are shown in Data Sheet 7. These results satisfied our final determination.

Evaluation

A. The vacuum pump and vacuum switch used for regulating the proper degree of vacuum in the surge tank, performed flawlessly. Over 100 recorded cycles were made without a failure of the vacuum system. The vacuum pump evacuated the surge tank to 8 in Hg below atmospheric pressure in 3 secs., which is less than that time supplied by the pump manufacturer. The ball valves and actuators operated in milliseconds as compared to the 1-2 sec operating time specified by the manufacturer. There appears to be no problem in this area.

Preliminary testing of the drain station using a vacuum of 6 in Hg proved to be totally ineffective (due to insufficient surge tank capacity) in completely draining the 155mm and 8 inch round of agent simulant. It was decided by the Test Engineer to abandon this low vacuum and continue the test using 8 in Hg and 10 in Hg only. A comparison of drain items using 8 in Hg and 10 in Hg vacuum shows that only about 2 seconds drain time is gained by using 10 in Hg. Since all drain times are within the established processing rate times, a vacuum of 8 in Hg below atmospheric pressure is adequate for draining all 3 rounds of agent.

The original design was to use an ultrasonic liquid level sensor to detect the level in the separator tank and in the munition and to sense the flow in the drain line of the separator tank when emptying. A problem, however, occurred shortly after testing began. Once the simulant made contact with the probe a small amount remained on the probe after the draining process was complete. This gave false indications, in the case of the separator tank, that the tank was still full after emptying. Cleaning of the probe cured the problem temporarily, but as testing progressed the problem reoccured. It was finally decided to abandon the ultrasonic type sensor. A solid state "safe-pak" type switch was purchased and substituted for the ultrasonic type sensor. Some minor problems were experienced with this sensor due to the fact the original piping design was based on the ultrasonic type probe and had to be modified later to accommodate this new probe. A redesign of the probe itself will be necessary.

B. In order to conduct these tests, the drain head was modified to accept a probe which could be adjusted for each munition depth (see Fig 3). Another probe, located in the drain line at the head, was electrically paralleled to the one in the munition. To satisfy the "munition empty" condition, both probes had to be free of any liquid contact. The purpose of the paralleling was to ensure that both the munition and the drain tube were empty. This concept worked provided the probe inside the munition was not touching the bottom. To prevent contact with the munitions bottom, a clearance of 1/16"-1/8" was maintained. This method not only reduced the drain cycle time but proved to be a more positive method of determining when the munition was empty.

Using this method, the part of the cycle time needed for the surge tank and drain line to return to atmospheric pressure was unnecessary. To get a



K-60

comparison in cycle times between this method of sensing the munition empty and the vacuum switch method the 155mm munition was tested using VX simulant at 40°F at both 8 in Hg and 10 in Hg vacuums.

As can be seen in Data Sheets 3 and 5, at 8 in Hg the drain cycle time went from 40 sec. down to 33 sec. At 10 in Hg the cycle time went from 39 sec. down to 31 sec. This time savings is chiefly due to the deletion of the requirement for the surge tank to return to atmospheric pressure.

C. In performing the test on the Rinse Station concept each munition was filled with water and drained, using the same tube for both operations (see Fig 3); the "full" and "empty" condition of the munition was measured by use of liquid level sensors. Vacuums of 8 in Hg and 10 in Hg again were used. Tests involving the 105mm and 155mm rounds were accomplished within the allotted cycle times. In the case of the 105mm round both filling and draining was performed in 16 seconds. The 155mm round took 68 seconds at a vacuum of 8 in Hg.

Some problems occurred with the 8 in round in that it became impossible to perform the drain portion of the cycle at either 8 in Hg or 10 in Hg. The surge tank capacity at these two vacuum levels was too small to completely drain the 8 in round filled to the top with water. The lowest possible vacuum that would completely drain the round (i.e., increase surge capacity) was 13 in Hg below atmospheric pressure. This gave a complete cycle time for filling and draining of 135 secs. This time is within the allotted rinse cycle time of 180 secs.

D. As recorded in Data Sheet 7 the greatest amount of simulant remained in the 8 inch round when testing with VX at 40°F. 26 ml was drawn from the bottom of the round, whereas 18 ml was drawn from the 155mm under the same conditions. Since there are no 105mm munitions filled with VX, no test was performed on this item.

Testing with GB simulant at 40°F was performed on all three rounds. The amount of simulant remaining was somewhat less than the VX simulant. Only 10 ml in the 105mm was left, whereas 12 ml and 13 ml in the 155mm and 8 inch rounds.

In order to obtain more data in this area it will be necessary at a later time to perform the same series of tests with GB and VX simulant at 70°F. These amounts will have to be considered when determining whether there is a need for the rinse station.

## Conclusions/Recommendations

The basic drain and rinse station concept has performed satisfactorily. The times recorded for both rinsing and draining are within the processing rate times established in September 1972. These are listed below and are compared with the PDR times. Both the actual drain cycle times and actual rinse cycle times were performed at 8 in Hg vacuum below atmospheric pressure except for the rinse cycle for the 8 inch round. As previously explained this had to be accomplished at 13 in Hg.

| Processing Rates | Actual Drain Cycle Time | Actual Rinse Cycle Time |
|---|---|---|
| 105mm every 72 secs*(1000/da) | 10 | 16 |
| 155mm every 111 secs*(650/da) | 33 | 68 |
| 8 inch every 180 secs*(400/da) | 76 | 135 |

In our testing the separator tank was emptied after each cycle. The longest recorded time for this operation was 22 seconds.

It is recommended that 8 in Hg vacuum below atmospheric pressure be used for the Drain Station and that, since time permits, the separator tank should be drained after each munition is emptied. If the decision is made to use the Rinse Station it will be necessary to increase the vacuum to 13 in Hg to accommodate the 8 inch round.

Further discussion will be required in the following areas:

1. The need to monitor the surge tank pressure at the Control Module. It is not necessary for satisfactory operation of the PDR machine, but could be an aid if problems develop with the drain and rinse stations.

2. Type of pump for emptying of the separator tank. Presently we are using a chem pump which has performed satisfactorily, but due to its construction the possibility exists that under actual operation it may not function properly due to the possibility of solids in the agent.

3. The type of flexible drain line for the draining of the munition. Tygon tubing was used during tests but will not be adequate for actual operation.

4. Design of a sensor probe installation for detecting the liquid in the drain lines and separator tank. The present design will not be suitable for actual operation.

*All cycles (Pull, Drain and Rinse) are concurrent.



K-62

5. The type of fill pump will have to be considered, pending decision on the rinse station. A flexi-liner pump was used in these tests, but may not be suitable during operation depending upon the rinse solution used.

The following are additional comments on the overall conduct of the test:

After the drain station tests were completed, but before rinsing began, the pipe fittings at the bottom of the surge tank were broken to determine if any liquid carryover was getting back into the surge tank. There was no trace of any moisture. Apparently this area will not present an operational problem.

While filling the round with water (simulating the rinse concept), there was a slight amount of liquid carryover into the drain line while filling. This did not affect the filling operation nor the draining of the round after filling. (See attached Drain Head Sketch). If this is objectionable an extra valve might be placed in the drain line at the head. Originally a solenoid valve was placed there but caused other problems so it was disregarded. A ball valve and actuator should be the only type considered since it is a direct thru type valve as opposed to the solenoid valve. The solenoid valve slowed down our drain time by 1/3. The control circuit would also have to be modified to open this valve while emptying the separator tank so the drain line can be vented to atmosphere.

A flow totalizer for measuring the volume of simulant passing through the system was incorporated into the piping. During the first series of drain operations it was noted the readings on the totalizer were incorrect. It was returned to the manufacturer for repair. Testing proceeded without the totalizer since the operation was independent (in a control sense) of the totalizer. The totalizer has been returned to us and checked but a problem still exists with it. It will be rechecked and installed in the system as soon as it performs accurately.

The attached data sheets 8 thru 13 are recommended logic diagrams for the drain and rinse stations and may be used as a reference in finalizing the PDR design. The times include other required functions such as:

Lowering hydraulic head - 4 secs
Index platen - 6 secs
Lock conveyor pins - 2 secs

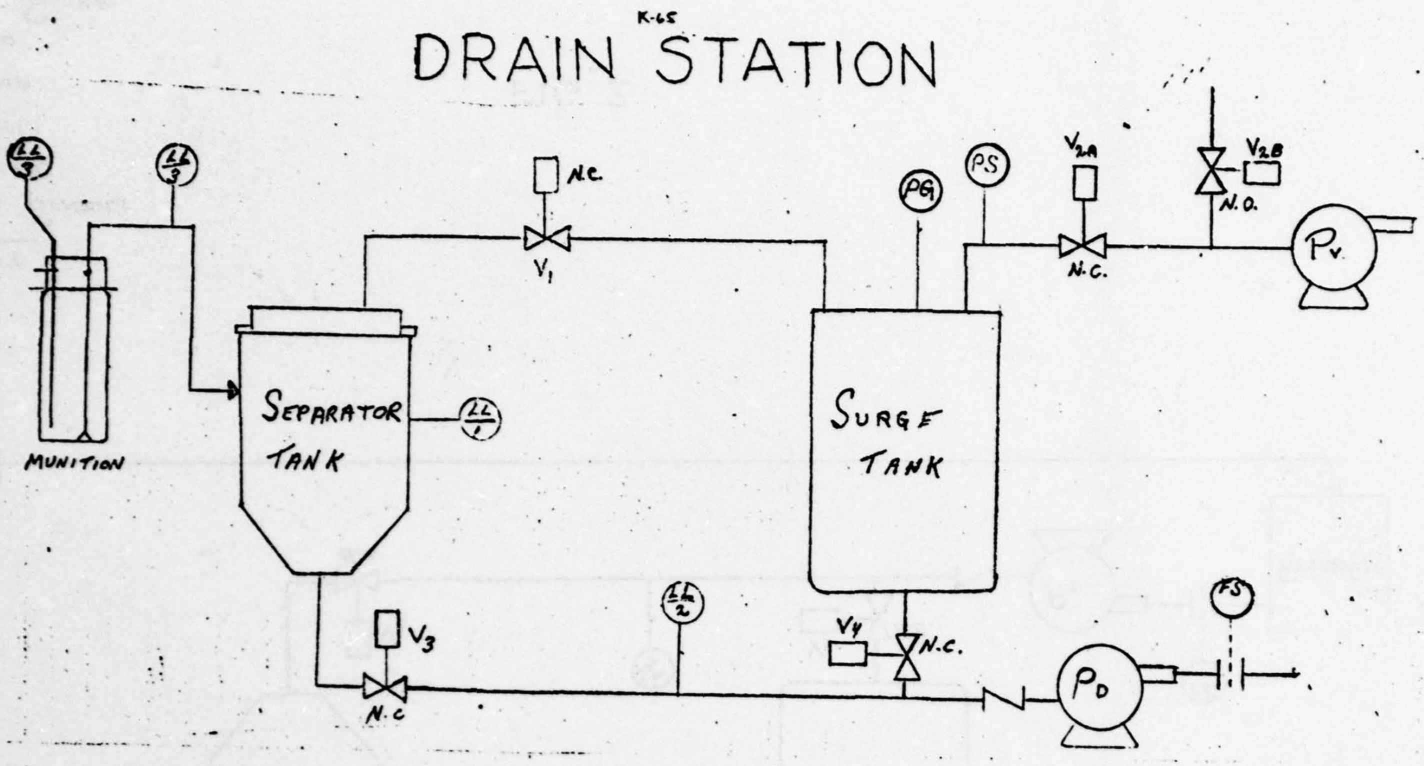
The two functions of lowering the head which takes 4 secs, can be paralleled with the evacuating of the surge tank which takes 3 secs. In each diagram the time for emptying the separator tank is shown for that particular munition. This function runs parallel with the raising of the hydraulic head.

## TABLE 1

## AGENT SIMULANTS

| Agent Simulated | Simulant | Agent Properties Viscosity (CP) | Agent Properties SP.GR. | Simulant Properties Viscosity | Simulant Properties SP.GR. |
|---|---|---|---|---|---|
| VX at 40°F | 71%(wt) glycerin at 70°F | 26.0 | 1.03 | 26.5 | 1.18 |
| VX at 70°F | 62%(wt) glycerin at 70°F | 12.0 | 1.01 | 12.5 | 1.16 |
| VX at 90°F | 56%(wt) glycerin at 70°F | 8.0 | 1.005 | 8.3 | 1.14 |
| GB at 40°F | 20%(wt) sucrose at 70°F | 2.0 | 1.12 | 1.95 | 1.08 |
| GB at 70°F | 16%(wt) calcium chloride at 70°F | 1.6 | 1.1 | 1.6 | 1.14 |
| GB at 90°F | 7%(wt) calcium chloride at 70°F | 1.2 | 1.08 | 1.2 | 1.06 |
| HD at 70°F | 20%(wt) magnesium sulfate at 70°F | 4.5 | 1.25 | 6.5 | 1.27 |

# DRAIN STATION

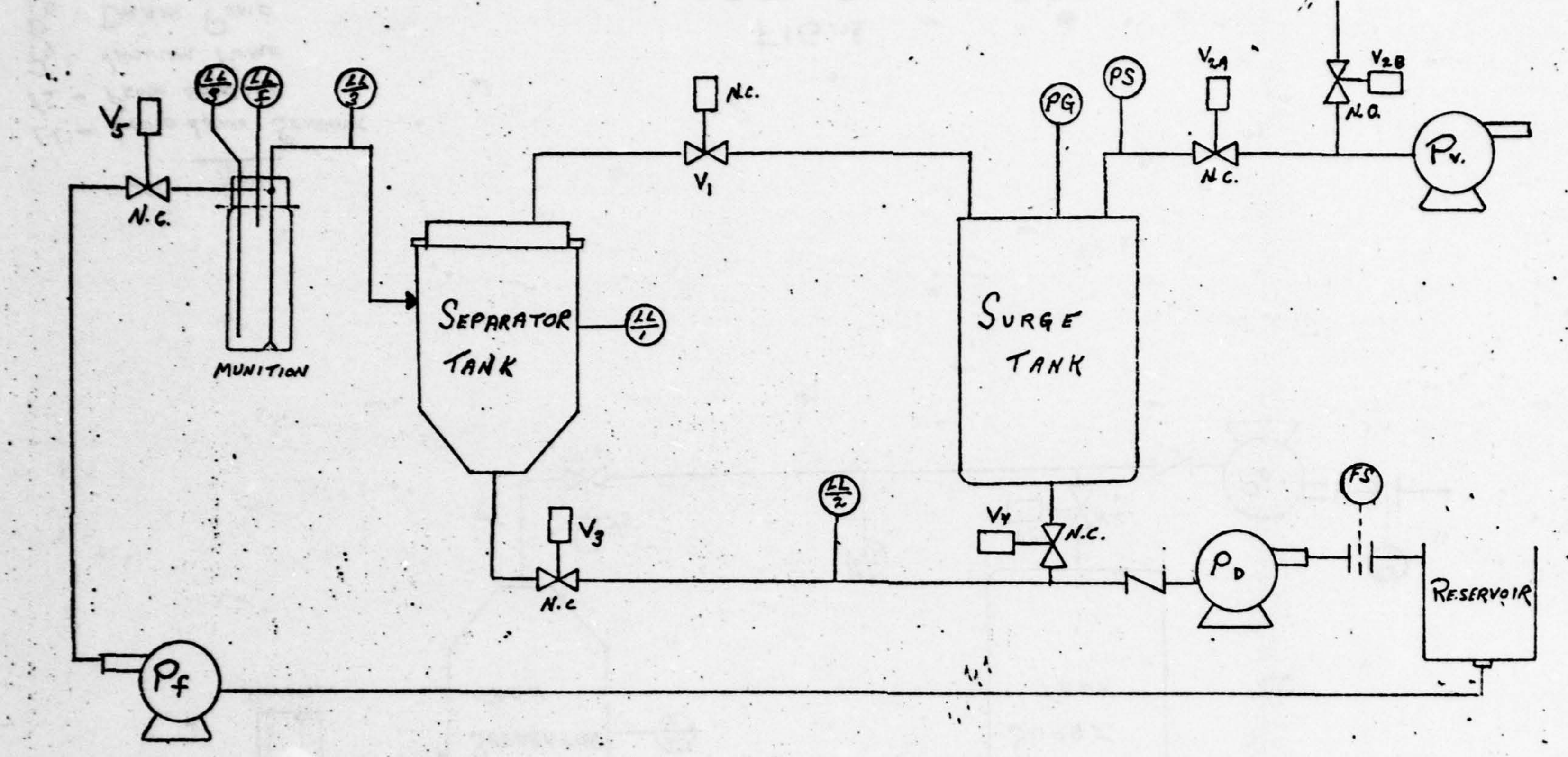



**KEY**

- LL - Liquid Level Sensors
- FS - Flow sensor
- $P_V$ - Vacuum Pump
- $P_D$ - Drain Pump
- PS - Pressure Sw.

FIG. 1

# RINSE STATION



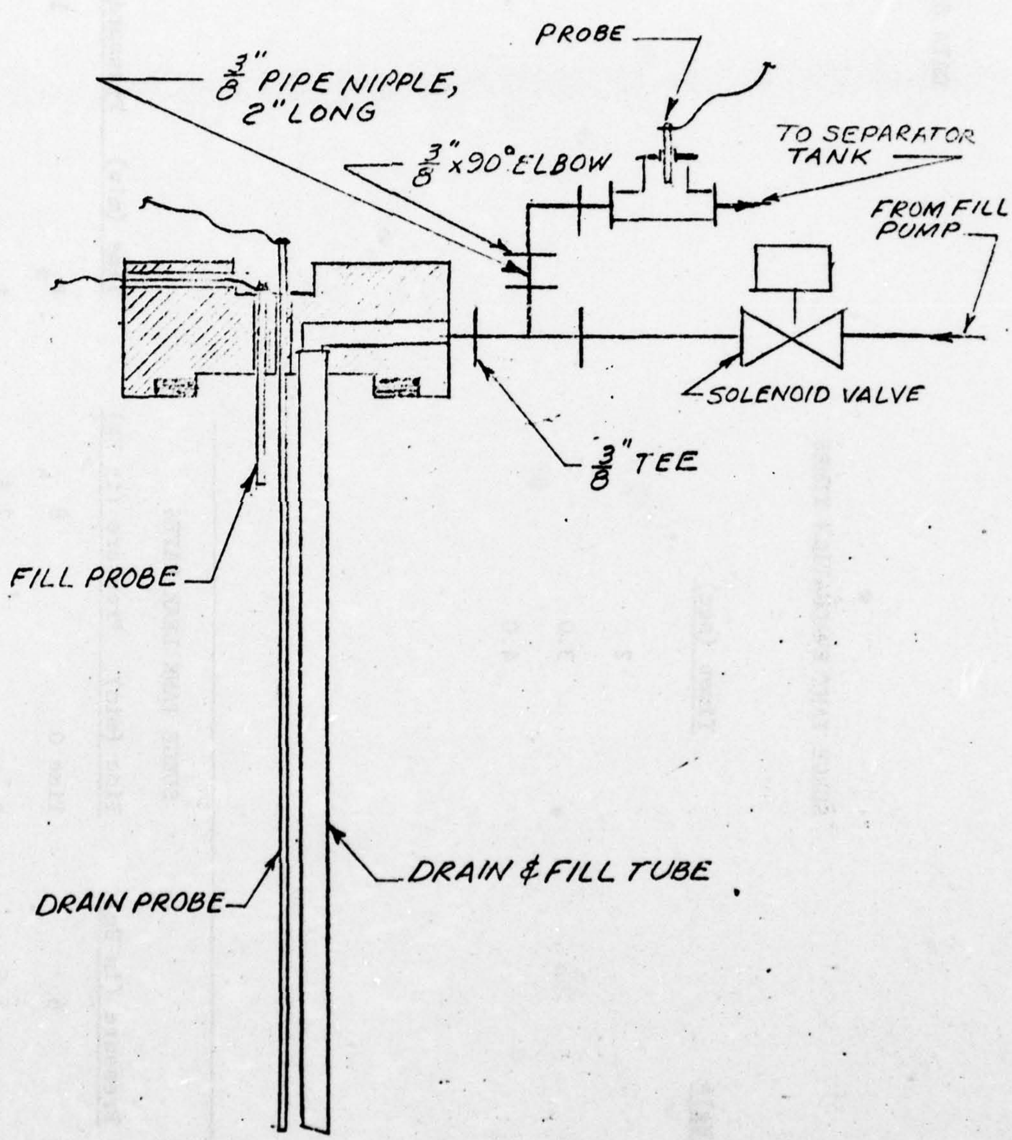

KEY

LL – Liquid Level Sensors
FS – Flow sensor
Pv - Vacuum Pump
PD - Drain Pump
Pf - Fill Pump
PS - Pressure Sitch

FIG. 2

K-67

DRAIN HEAD




21

Fig. 3

MAY 10, 1973

DATA SHEET 1

## SURGE TANK EVACUATION TIMES

| Pressure (in Hg)* | Times (sec) |
|---|---|
| 6 | 2 |
| 8 | 3.0 |
| 10 | 4.0 |

## SURGE TANK LEAK RATES

| Time (min) | Pressure (in Hg) | Time (min) | Pressure (in Hg) | Time (min) | Pressure (in Hg) |
|---|---|---|---|---|---|
| Time 0 | 6 | Time 0 | 8 | $t_o$ | 10 |
| $t_{1\ Min}$ | 5.5 | $t_{1\ Min}$ | 7.5 | $t_{1\ Min}$ | 9.5 |
| $t_{5\ Min}$ | 5.5 | $t_{4\ Min}$ | 7.25 | $t_{5\ Min}$ | 9.3 |
| $t_{10\ Min}$ | 5.5 | $t_{5\ Min}$ | 7.0 | $t_{8\ Min}$ | 9.0 |
| | | $t_{8\ Min}$ | 7.0 | $t_{10\ Min}$ | 9.0 |

*Pressure refers to in Hg below atmospheric pressure

k-69

DATA SHEET 2

## 105 MUNITION DRAIN TIMES

| Simulant | | Vacuum 8 in Hg | Vacuum 10 in Hg |
|---|---|---|---|
| GB | 40°F | 3 + 7 + 4 = 14 | 4 + 5 + 6 = 15 |
| | 70°F | 3 + 6 + 4 = 13 | 4 + 4 + 6 = 14 |
| | 90°F | 3 + 6 + 4 = 13 | 4 + 4 + 6 = 14 |
| HD | 70°F | 3 + 6 + 6 = 15 | 4 + 6 + 6 = 16 |

NOTE: First figure is that time required to evacuate the surge tank.
Second figure is actual drain time.
Third figure is that time required for the surge tank to return to atmospheric pressure, completing the cycle.

DATA SHEET 3

## 155mm MUNITION DRAIN TIMES SEC

| Simulant | | Vacuum 8 in Hg | Vacuum 10 in Hg |
|---|---|---|---|
| VX | 40°F | 3 + 30 + 7 = 40 | 4 + 27 + 8 = 39 |
| | 70°F | 3 + 20 + 6 = 29 | 4 + 18 + 6 = 28 |
| | 90°F | 3 + 17 + 6 = 26 | 4 + 15 + 6 = 25 |
| GB | 40°F | 3 + 17 + 7 = 27 | 4 + 16 + 7 = 27 |
| | 70°F | 3 + 15 + 7 = 25 | 4 + 14 + 6 = 24 |
| | 90°F | 3 + 15 + 6 = 24 | 4 + 12 + 6 = 22 |
| HD | 70°F | 3 + 23 + 5 = 31 | 4 + 19 + 7 = 30 |

**NOTE:** First figure is that time required to evacuate the surge tank.
Second figure is actual drain time.
Third figure is that time required for the surge tank to return to atmospheric pressure, completing the cycle.

DATA SHEET 4

## 8" MUNITION DRAIN TIMES

| Simulant | | Vacuum 8 in Hg | Vacuum 10 in Hg |
|---|---|---|---|
| VX | 40°F | 3 + 73 + 7 = 83 | 4 + 61 + 9 = 74 |
| | 70°F | 3 + 48 + 7 = 58 | 4 + 41 + 9 = 54 |
| | 90°F | 3 + 40 + 6 = 49 | 4 + 33 ÷ 7 = 44 |
| GB | 40°F | 3 + 38 + 6 = 47 | 4 + 35 + 7 = 46 |
| | 70°F | 3 + 35 + 6 = 44 | 4 + 33 + 7 = 44 |
| | 90°F | 3 + 34 + 5 = 42 | 4 + 30 + 7 = 41 |

**NOTE:** First figure is that time required to evacuate the surge tank.
Second figure is actual drain time.
Third figure is that time required for the surge tank to return to atmospheric pressure.

DATA SHEET 5

155mm MUNITION DRAIN TIMES (SECS)

| Simulant | Vacuum 8 in Hg | Vacuum 10 in Hg |
|---|---|---|
| VX @ 40°F | 3 + 30 = 33 | 4 + 27 = 31 |

NOTE: First figure is that time required to evacuate the surge tank.
Second figure is drain time.

DATA SHEET 6

RINSE AND DRAIN TIMES (WATER) (SEC)

| Munition | Fill Time | Drain: 8 in Hg | Drain: 10 in Hg | Total Time |
|---|---|---|---|---|
| 105mm | 9 | 7 | | 16 |
| | 9 | | 7 | 16 |
| 155mm | 29 | 39 | | 68 |
| | 29 | | 30 | 59 |
| 8 inch | 58 | Neither 8 in Hg or 10 in Hg is sufficient vacuum to empty this round when filled to maximum. | 13 in Hg: 77 | 135 |

DATA SHEET 7

## SIMULANT REMAINING AFTER DRAIN (MILLILITERS)

| Munition | Simulant VX @ 40°F | Simulant GB @ 40°F |
|---|---|---|
| 105mm | No test | 10 |
| 155mm | 18 | 12 |
| 8" | 26 | 13 |

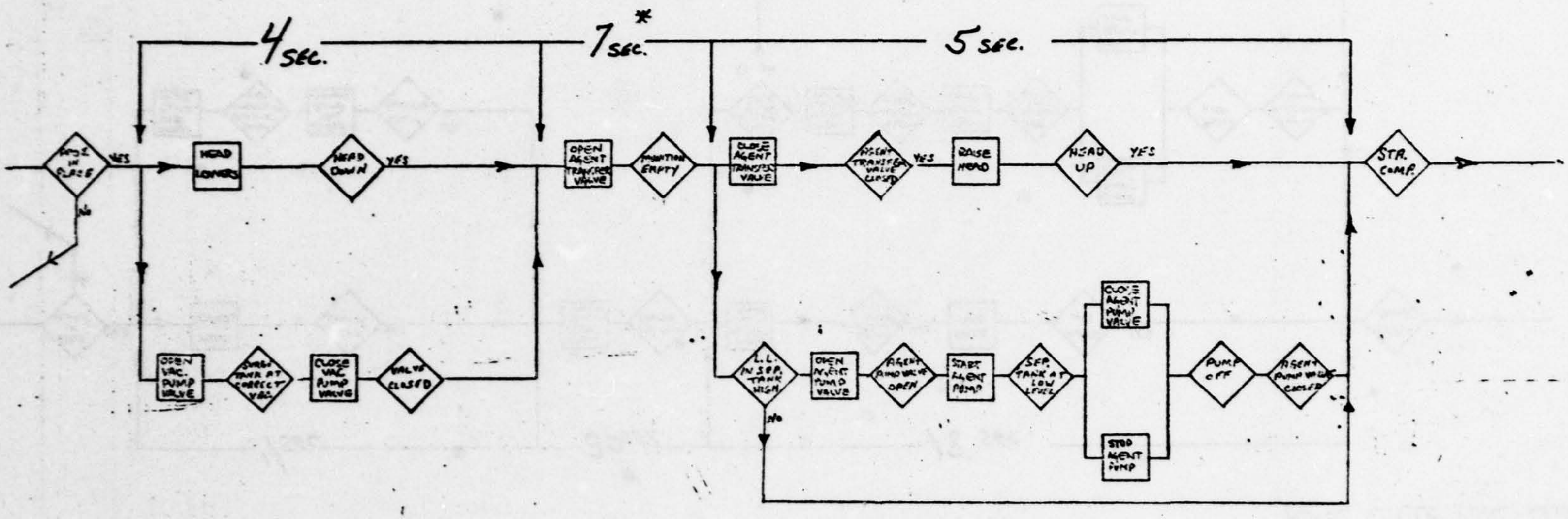
ROUND: 105 MM

# LOGIC DIAGRAM FOR DRAIN STATION - PDR

K-75

DATA SHEET

TOTAL CYCLE TIME: 16 SEC




* DRAIN TIME IS WORST CONDITION - GB @ 40°F.

NOTE: ADDITIONAL TIMES REQUIRED

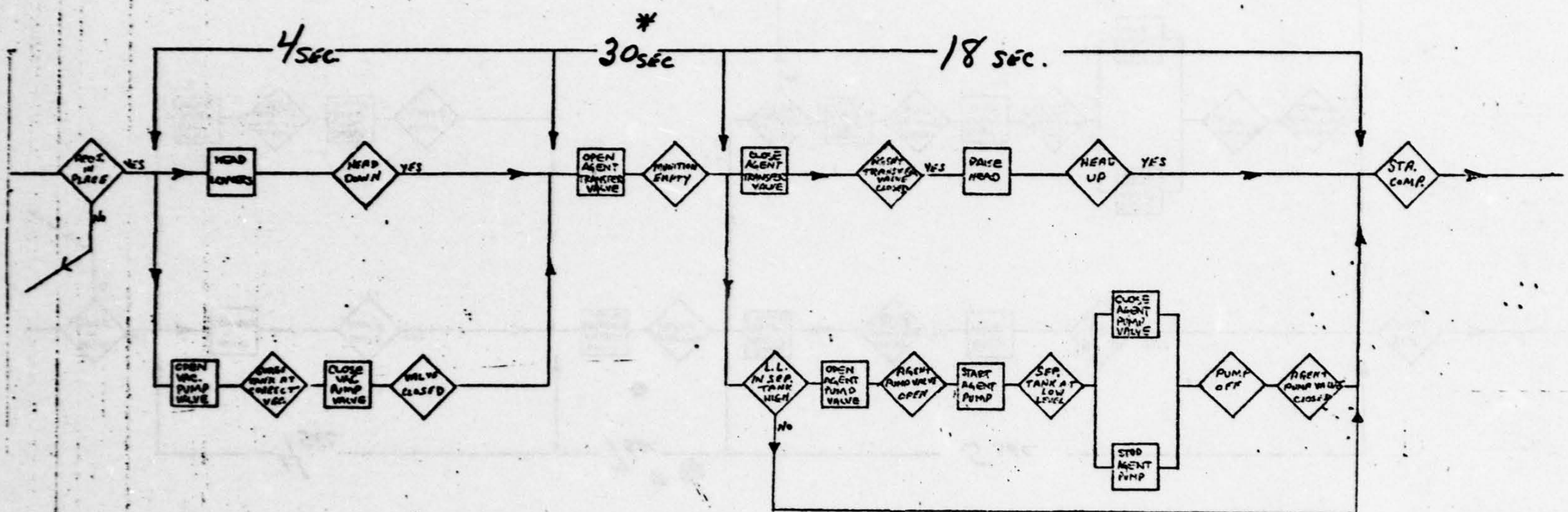
1. 6 SEC TO INDEX PLATEN
2. 2 SEC TO LOCK PINS

ROUND: 155 MM

# LOGIC DIAGRAM FOR DRAIN STATION - PDR

DATA SH...

TOTAL CYCLE TIME: 52 SEC




* DRAIN TIME IS WORST CONDITION - VX @ 40°F

NOTE: ADDITIONAL TIMES REQUIRED

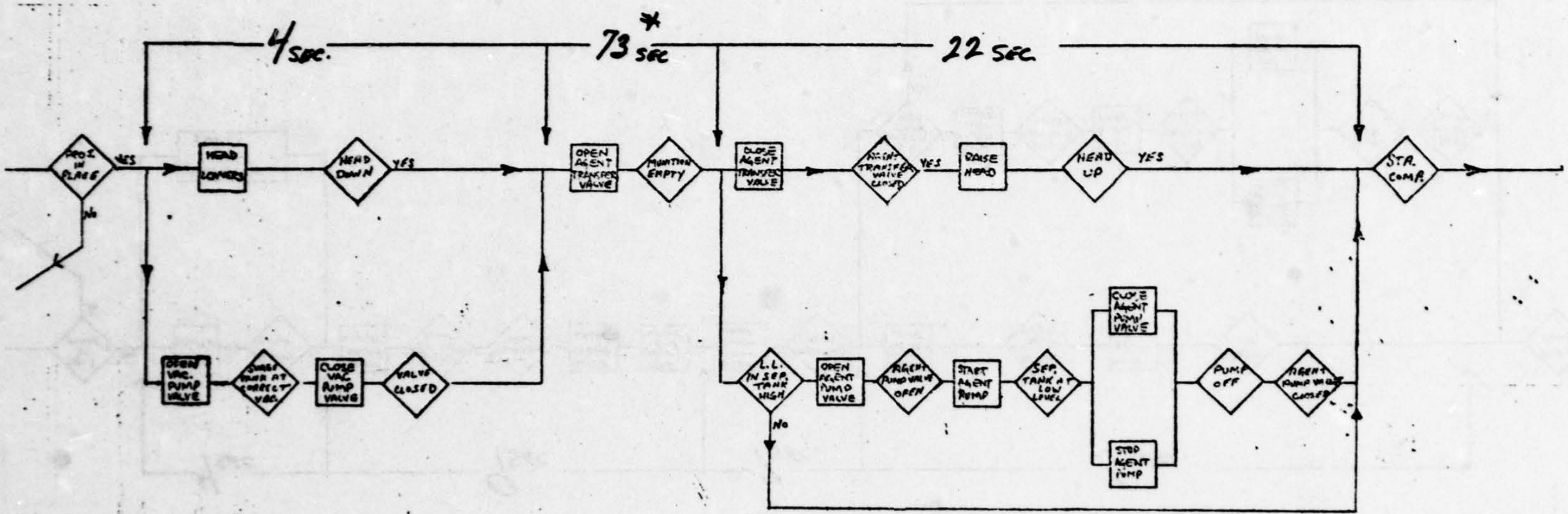
1. 6 SEC TO INDEX PLATEN
2. 2 SEC TO LOCK PINS

COND: 8 INCH

# LOGIC DIAGRAM FOR DRAIN STATION - PDR

DATA SHEET

TOTAL CYCLE TIME: 99s




* DRAIN TIME IS WORST CONDITION - VX @ 40°F.

NOTE: ADDITIONAL TIMES REQUIRED

1. 6 SEC TO INDEX PLATEN
2. 2 SEC TO LOCK PINS

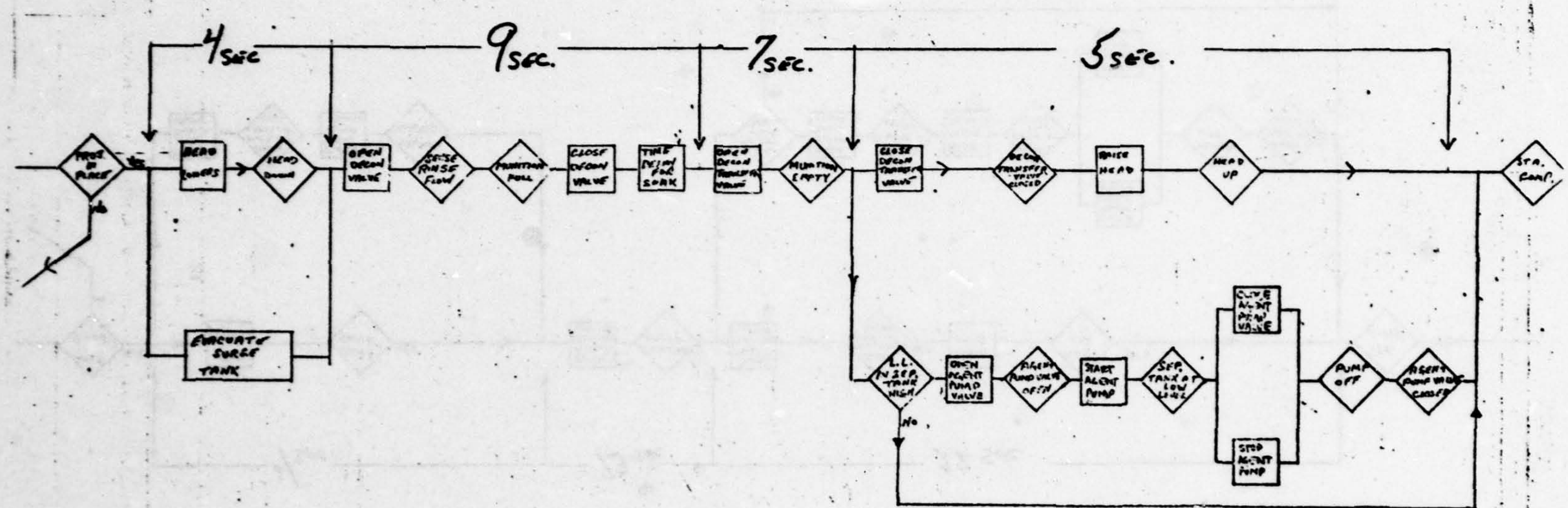
31

105MM

LOGIC DIAGRAM FOR RINSE STATION - PDR

DATA SHEET

TOTAL CYCLE TIME: 25




Additional Times Required:

6 secs. To Index Platen

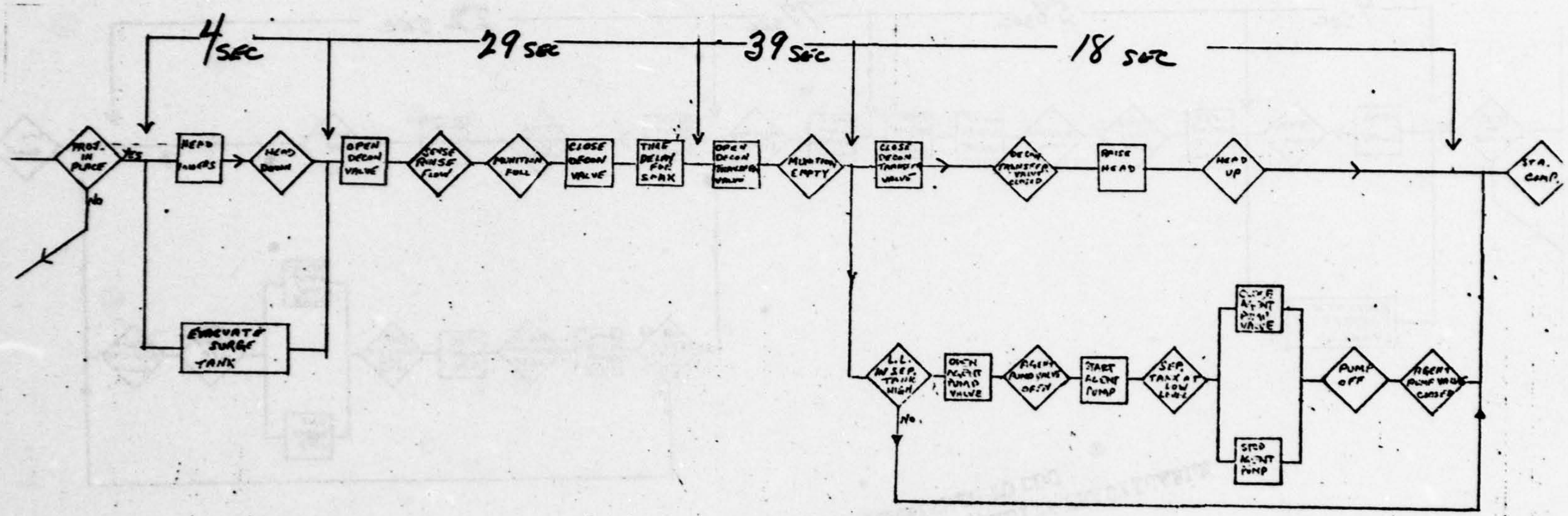
2 secs. To Lock Pins

...: 13.5 MM.

# LOGIC DIAGRAM K-29 FOR RINSE STATION - FDR

DATA SHEET 1.

TOTAL CYCLE TIME: 96




ADDITIONAL TIMES REQUIRED:

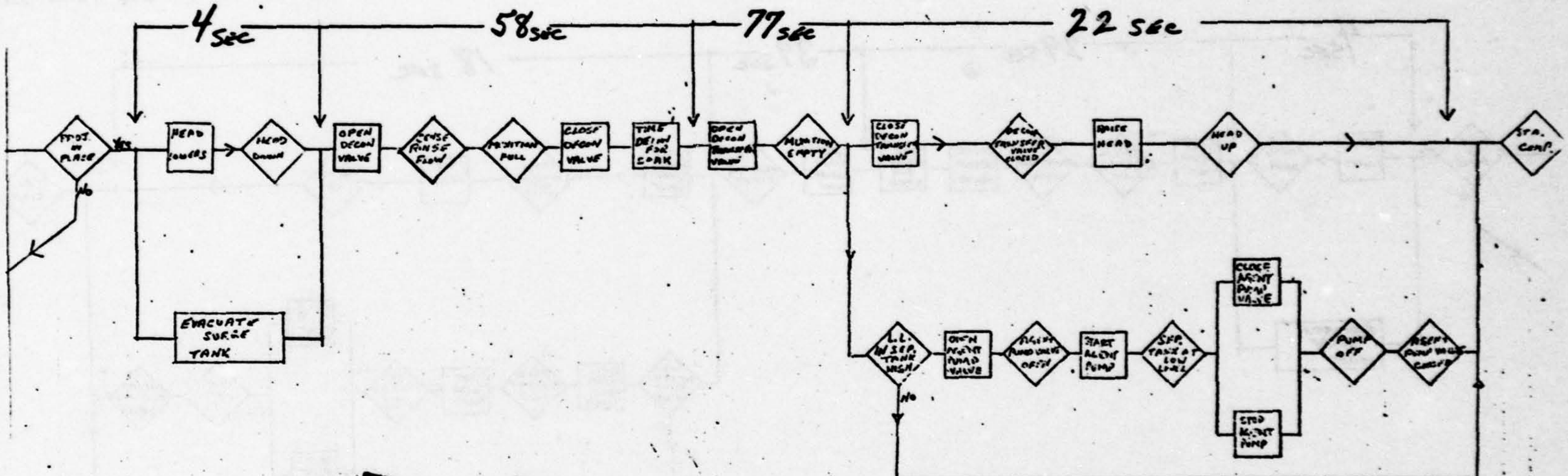
6 SECS. TO INDEX PLATEN

2 SECS. TO LOCK PINS

8 INCH

# LOGIC DIAGRAM FOR RINSE STATION - FDR

TOTAL CYCLE TIME: 16






ADDITIONAL TIMES REQUIRED:
6 SEC TO INDEX PLATEN
2 SEC TO LOCK PINS

Distribution List

SMUEA-DM (Chief, Demil/Disposal Office)

SMUEA-DM (General Projects Manager,
Demil/Disposal Office)

SMUEA-DM-CAMDS (Op Ofc)

SMUEA-DM-CAMDS (Chief, Engineer Ofc)

SMUEA-DM-CAMDS (Chief, Safety)

AMXDC (PMO)

SMUEA-DM (file)

AMXTE-AEO (Chief, AEO)

BB#18 PULL DRAIN AND RINSE (PDR)

CAMDS TEST SUMMARY

PDR AGENT DRAIN

RINSE TEST

TEST NO. CAMDS 18-2

January 1974

SUBMITTED BY:

Joseph Fitzgerald
Mech Engr, CAMDS

Donald Walker
Elec Tech, CAMDS

APPROVED BY:

JOHN K. BARTEL
CAMDS Project Manager

TABLE OF CONTENTS


| | Page |
|---|---|
| INTRODUCTION | 1 |
| OBJECTIVES | 1 |
| SUMMARY | 1 |
| TEST APPARATUSES | 1 |
| RESULTS ANALYSIS | 1 |
| CONCLUSIONS/RECOMMENDATIONS | 4 |
| APPENDICIES | |
| 1. TEST DATA | |
| 2. SIMULANT AGENT PROPERTIES | |

INTRODUCTION

Prior test results have shown the prototype Drain Station and Rinse Station of the Pull, Drain and Rinse (PDR) system are capable of meeting the scheduled munition processing rates. The basic concept utilized evacuated surge and separator tanks to provide suction to the agent or decon solution within the munitions. A subsequent decision to transfer the agent and spent decon solution outside the PDR after each munition drain and rinse cycle affected a possible design improvement. The modified design consists of using a diaphragn pump in lieu of the tanks and associated hardware. Tests were performed on the modified design and the results are compared with those of the prototype design.

OBJECTIVES

1. Drain Station. Determine the time required to drain 105mm, 155mm and 8 inch munitions containing simulant VX and GB and measure the residual volume of simulant. Compare the results with those of the prototype design.

2. Rinse Station. Determine the time required to drain the munitions when filled with a simulant decon solution and compare with those of the prototype design.

SUMMARY

Test results indicate that the modified design represents a significant improvement for the Drain Station and Rinse Station of the PDR. Material and labor cost savings can be realized, residual agent within the munitions (after completion of the drain cycle) can be minimized and the cycle times of both stations can be reduced.

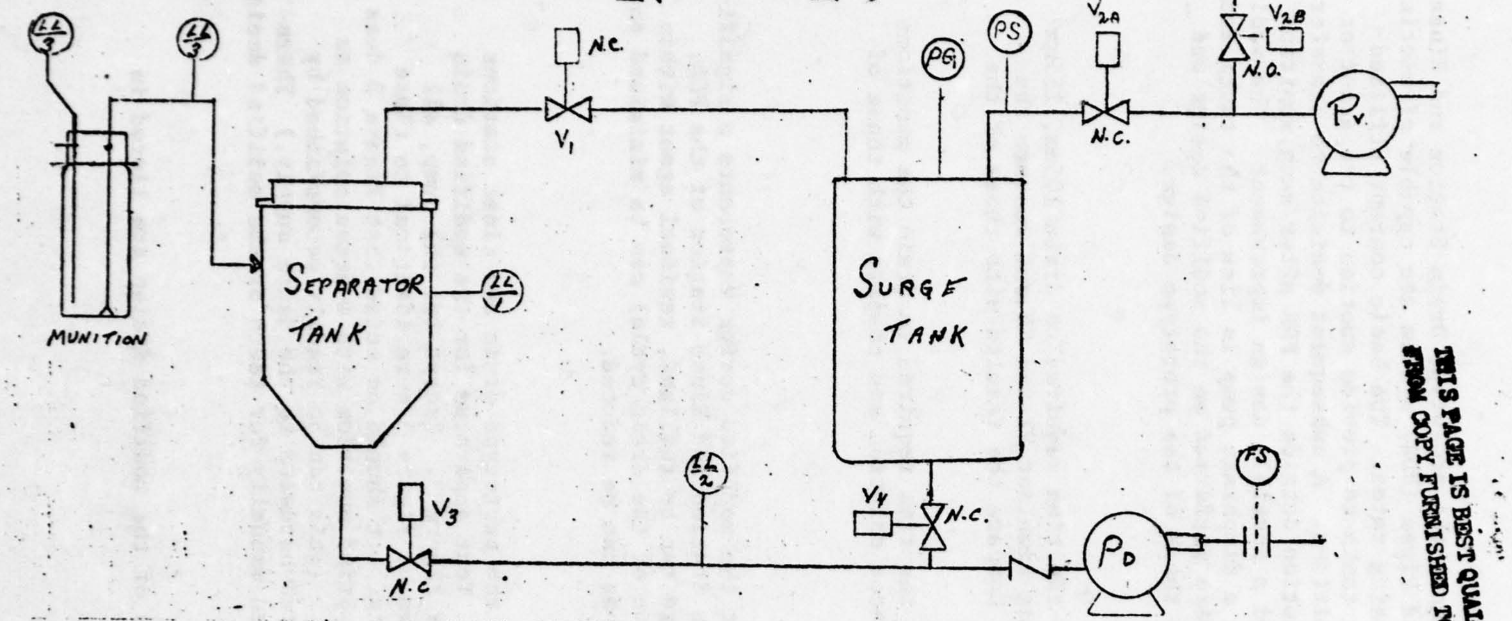
TEST APPARATUSES

Test apparatuses used for the prototype drain and rinse stations are shown by Figures 1 and 2. Test apparatus for the modified drain and rinse stations is shown by Figure 3. Except for the pump, all components and dimensions shown by Figure 3 were identical to those used during the prototype tests. It should be noted that Figure 3 does not provide for filling the emptied munition with a decon solution as required in the rinse station. (This can be readily accomplished by attaching a line with associated hardware to the decon supply.) Therefore, the munitions were filled manually for tests of the modified design.

RESULTS ANALYSIS

Data recorded during tests of the modified design are listed in Appendix 1.

# DRAIN STATION
(Prototype Design)





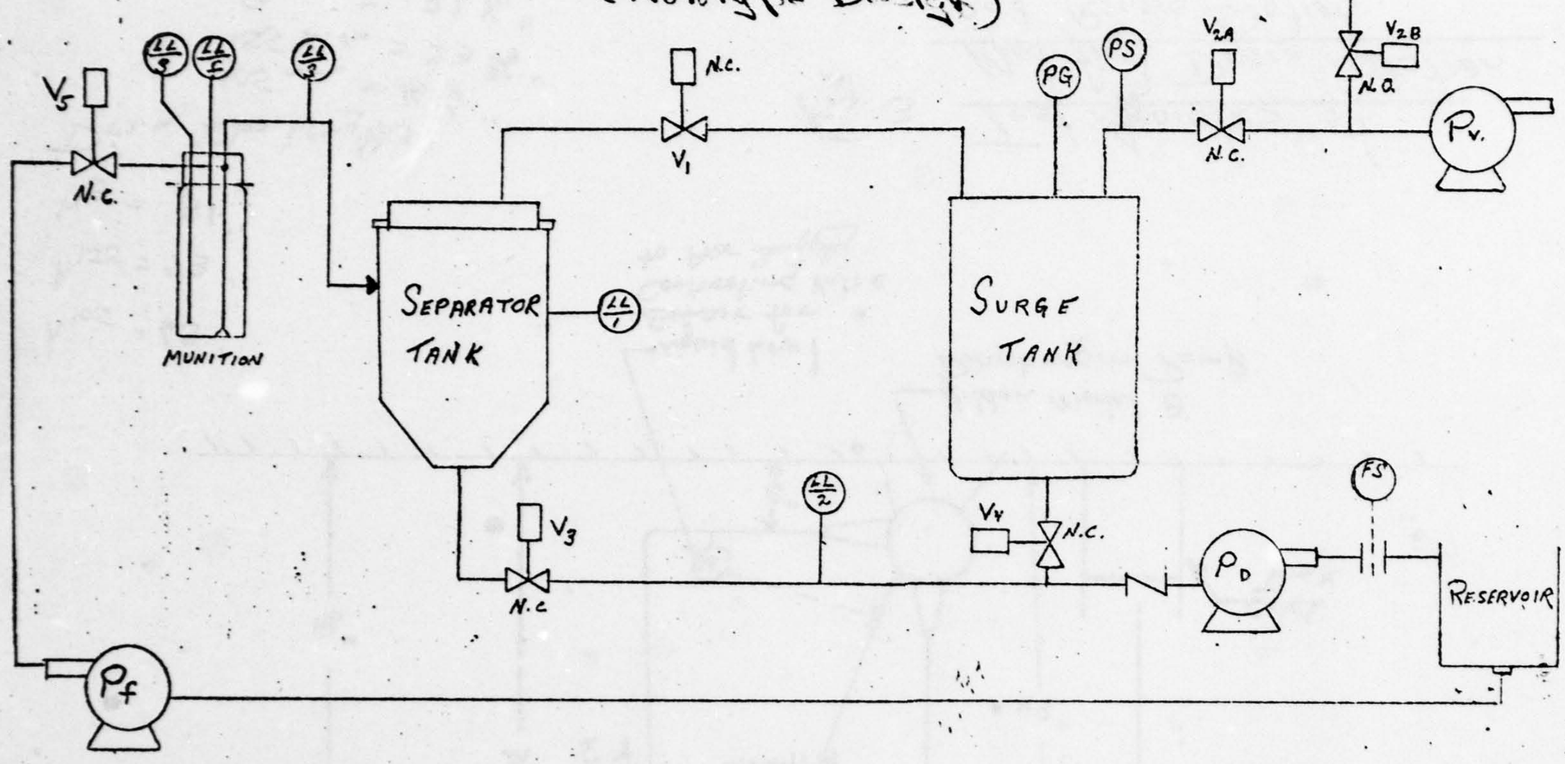

KEY

LL – Liquid Level Sensors
FS – Flow Sensor
$P_V$ – Vacuum Pump
$P_D$ – Drain Pump
PS – Pressure Sw.

FIG. 1

Reference: MEMO, SMUEA-DM, 18 Jun 73, Subj; PDA Test Summary

# RINSE STATION
(Prototype Design)

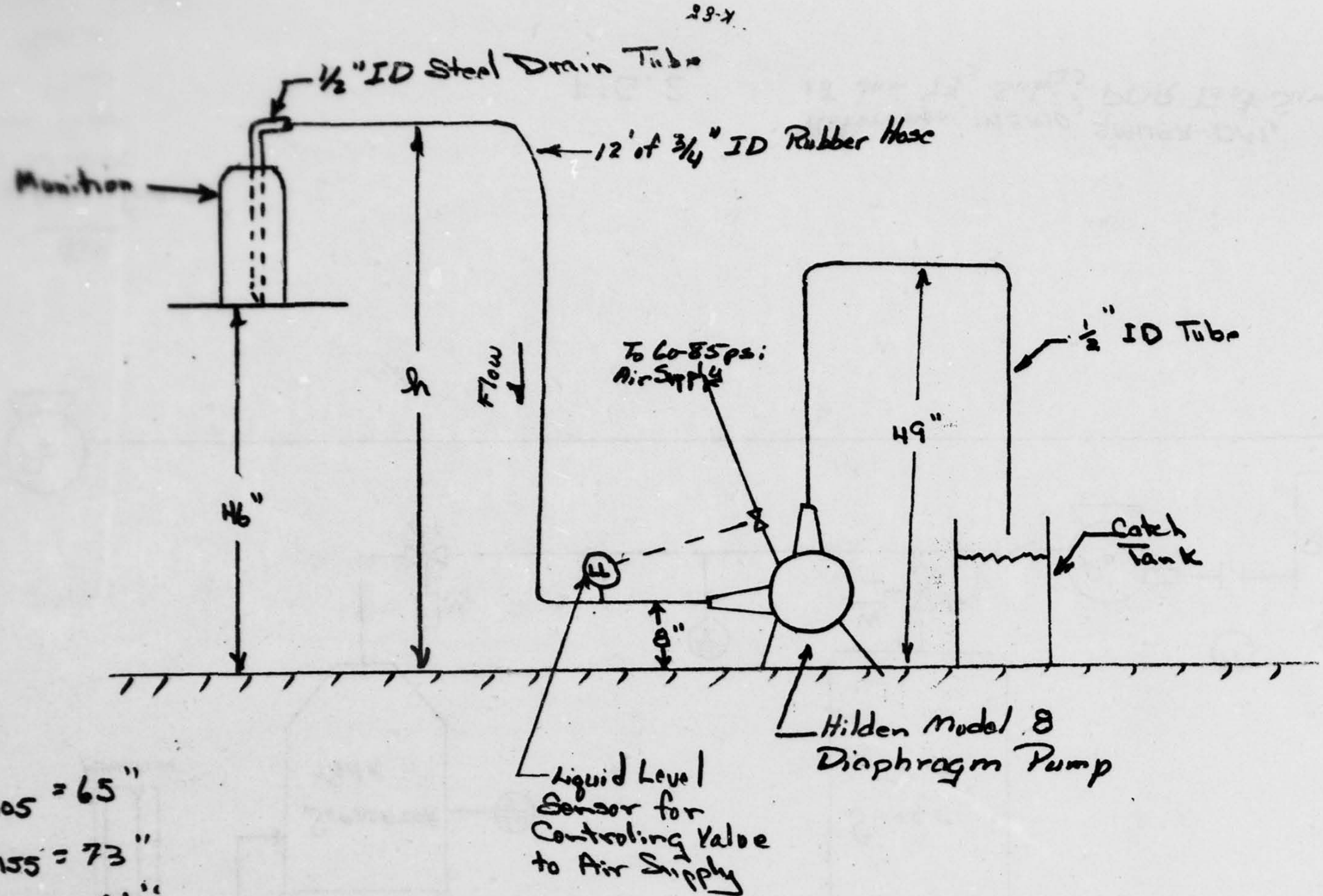



KEY

LL - Liquid Level Sensors
FS - Flow sensor
$P_v$ - Vacuum Pump
$P_D$ - Drain Pump
$P_f$ - Fill Pump
PS - Pressure Switch

FIG. 2

Reference: MEMO, SMUEA-DM, 18 Jun 73, Subj; PDR Test Summary




$h_{105} = 65"$
$h_{155} = 73"$
$h_{8} = 81"$

Drain Tube Lengths:

105 mm = 16 1/4"
155 mm = 23 3/4"
8 in. = 31 1/4"

Fig 3. Test Apparatus of Modified Drain Station and Rinse Station

1. Drain Station.

a. Drain Times of Simulant Agents. As shown by Figure 4, analysis of the data indicates the proportionality of time required to drain 99% of a given liquid to the total volume of liquid. The effect of other flow parameters, i.e., viscosity is also indicated. For example, 6 liters of simulant VX at 40°F with a viscosity of 1 cp requires 15.8 seconds to drain 99% of the total volume. The same volume of simulant GB at 70°F with a viscosity of 2 cp, require 13.2 seconds to drain. Pertinent simulant and agent properties are listed in Appendix 2.

b. Residual Volumes of Simulant Agents. Additional parameters which affect the time required to remove the remaining 1% of liquid volume ($V_R$) include internal geometry and surface area of the munition and location of the drain tube within the munition. During tests of the modified design, the end of the drain tube touched the bottom center of the munition. Intuitively, one would expect an initial rapid decrease in $V_R$ followed by a gradual reduction with time. An estimate of the $V_R$-time dependency was obtained by subtracting the drain time ($d_t$) from the total pumping time ($p_t$) and comparing the resulting time with the measured $V_R$. As indicated by Figure 5, continued pumping does decrease the residual volume, but has negligible effect after a certain time interval. This time interval is but a part of the total time of the drain cycle - which must be within the scheduled munition processing rates. Table 1 lists the maximum time available for continued pumping of the munitions.

TABLE I. SIMULANT AGENT DRAIN TIMES

| Munition @ 40°F | Sch Unit Process (sec) | Req'd for Mech (1) (sec) | Req'd for $d_t$ (2) (sec) | Max. Available for Cont. Pump (sec) |
|---|---|---|---|---|
| 105mm GB | 72 | 16 | 2 | 54 |
| 155mm VX | 111 | 16 | 8 | 87 |
| 8 - in VX | 180 | 16 | 17 | 147 |

(1) Includes time to index platen, lock pins, raise and lower drain head.

(2) Obtained from Figure 4.

The time of 54, 87 and 147 seconds for continued pumping of the "worst case" 105mm, 155mm and 8 inch munitions respectively are well in excess of those required to minimize the residual volume, as shown by Figure 5.

For comparison, residual volumes for the total pumping times indicated are listed in Table 2 for the prototype and modified designs. Pumping times, total and residual simulant agent volumes of the prototype design

were obtained from the referenced report. For the modified design, some extrapolation was necessary. Drain time was obtained from Figure 4 using the given volume of simulant agent. Figure 5 was then used to determine the residual volume for the time interval (pump-drain time).

TABLE 2. $V_R$-TIME FOR THE PROTOTYPE AND MODIFIED DESIGNS

| | 105mm | | 155mm | | | | 8 inch | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 666 ml GB | | 2700 ml GB | | 2950 ml VX | | 6030 ml GB | | 6580 ml VX | |
| | 40°F | 70°F | 40°F | 70°F | 40°F | 70°F | 40°F | 70°F | 40°F | 70°F |
| Total Pump Time (sec) | 5 | 4 | 16 | 14 | 27 | 18 | 35 | 33 | 61 | 41 |
| $V_R$(ml): Prototype | 10 | - | 12 | - | 18 | - | 13 | - | 26 | - |
| Modified | 7 | 7 | 9 | 8 | 9 | 10 | 6 | 4 | 5 | 7 |

2. Rinse Station. Drain times of the water (simulant decon solution) filled munitions are listed in Table 3. Fill times are estimated to be equal to the drain times since the respective pressure heads, using the apparatus of Figure 3, were 6 ft and 6.5 ft, while the diaphragm pump is rated at 20 ft. For comparative purposes, drain times of the prototype rinse station are listed. Fill times of the prototype rinse station are not applicable for comparison since a smaller pump was used in the filling operation.

TABLE 3. RINSE STATION CYCLE TIMES

| | Vol (ml) | Req'd for Mech (sec)(1) | Fill Time(sec)(2) | Drain Time Prot | Drain Time Mod | Total Cycle(sec) Prot | Total Cycle(sec) Mod | Allow(3) |
|---|---|---|---|---|---|---|---|---|
| 105mm | 1,250 | 16 | 2.5 | 7 | 2.5 | 33.5 | 29 | 72 |
| 155mm | 4,210 | 16 | 8.5 | 30 | 8.5 | 62.5 | 40 | 111 |
| 8 in. | 10,820 | 16 | 21.5 | 77 | 21.5 | 122.5 | 67 | 180 |

(1) Includes time to index platen, lack pins, lower and raise the fill/drain head.

(2) Fill time estimated to be equal drain time, based on use of the diaphragm pump of Figure 3.

(3) Based on scheduled munition processing rates.

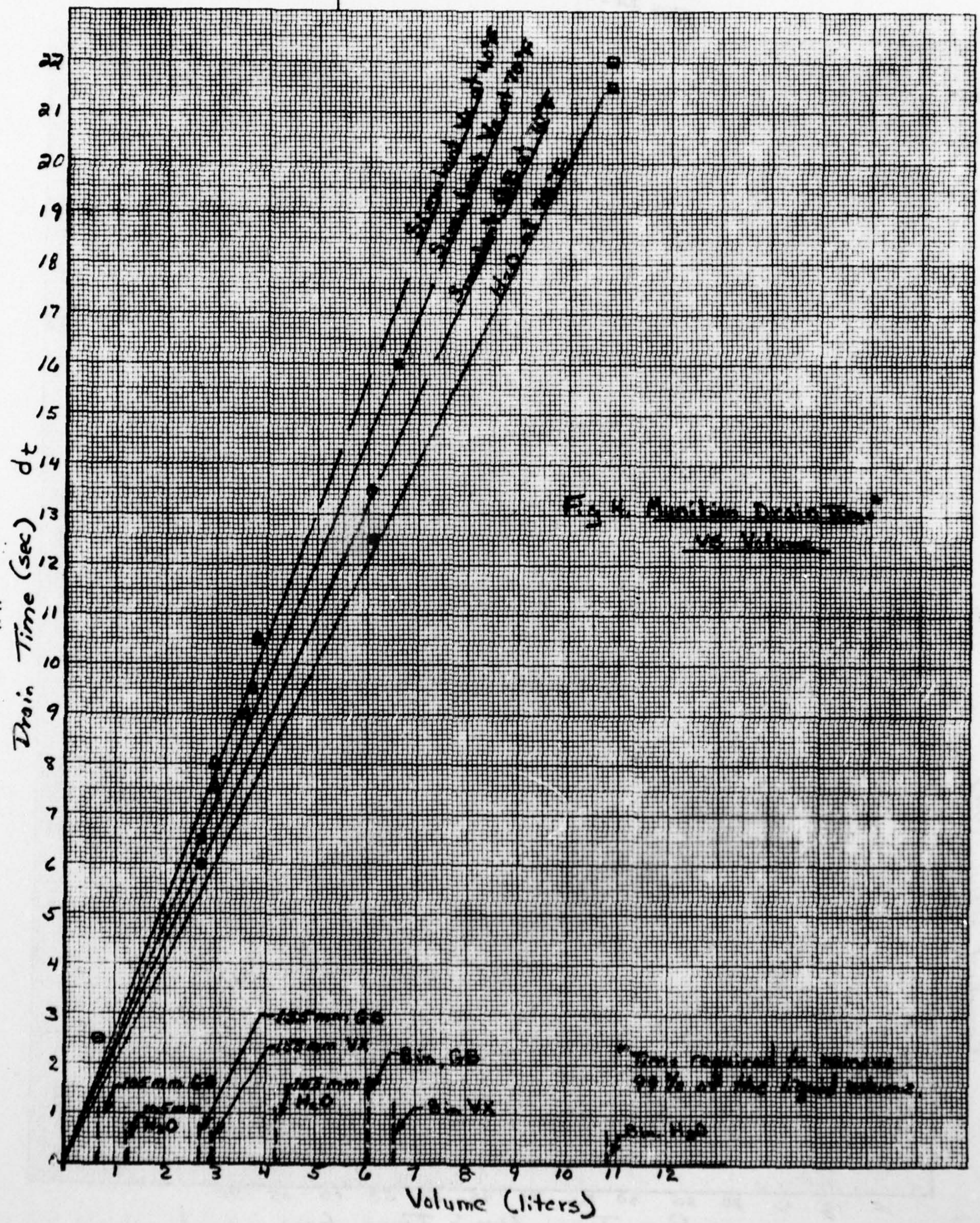



Fig 4. Munition Drain Time* vs Volume

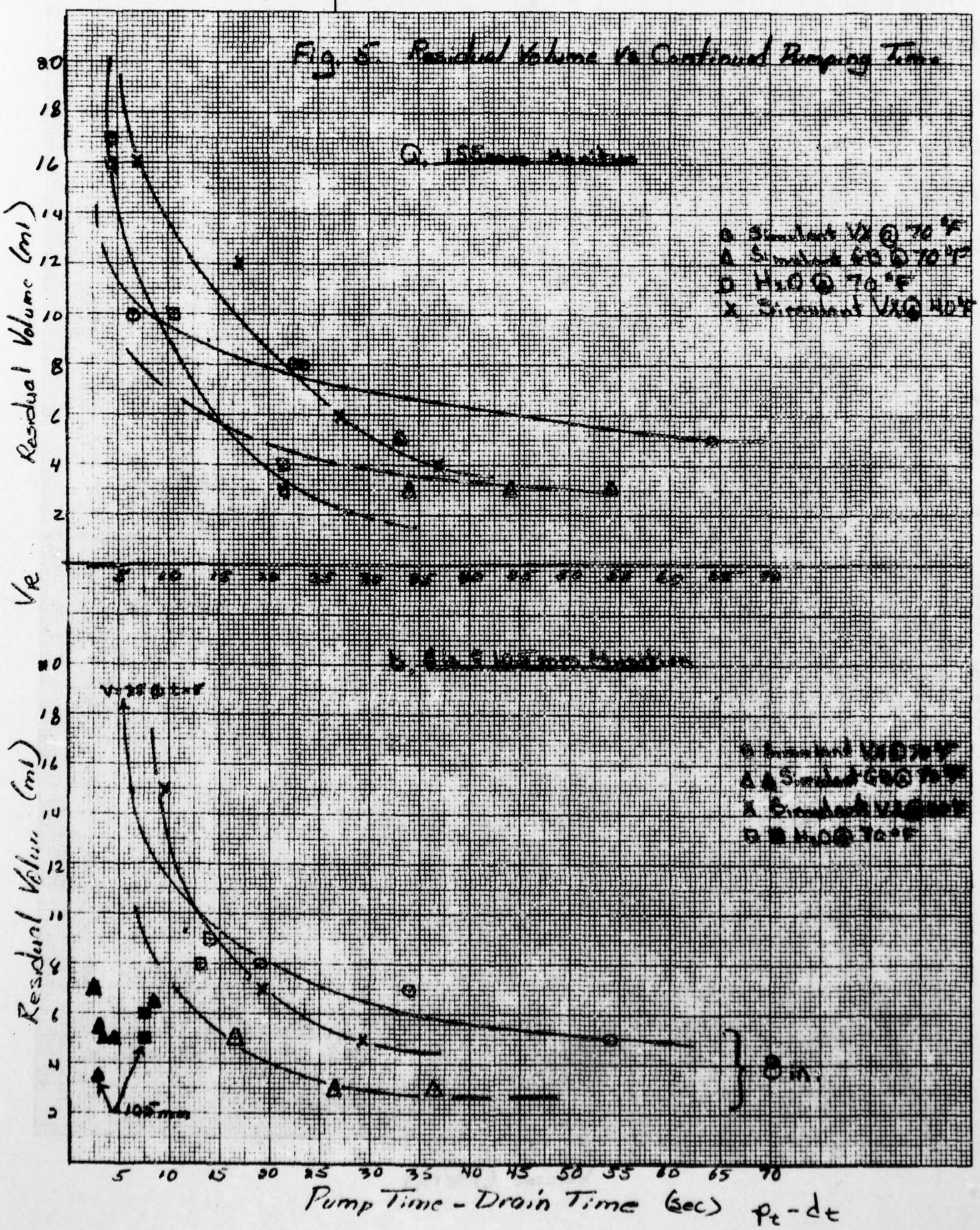


Fig. 5. Residual Volume vs Continued Pumping Time
Residual Volume (ml)
$V_R$
Residual Volume (ml)
H₂O @ 70°F
Pump Time - Drain Time (sec)
$p_t - d_t$

3. General. The following comments pertain to the overall test results.

a. During the initial tests of the modified design, the liquid level sensor was used to control the on-off action of the pump. The sensor output actuated the solenoid valve in the air supply line to the pump. Two problems were encountered with the sensor: (1) "Bridging" action at the end of the sensor probe caused erroneous operation of the liquid level controller, and (2) varying the depth to which the sensor probe was inserted into the flow line caused a corresponding variance in the time of pump operation. Neither of these problems significantly affected attainment of test objectives. In addition, both can be readily eliminated by use of a suitable adapter for the sensor probe.

b. At the end of a test run the residual volume was removed by a syringe. Obviously some agent remained as a thin film on the internal surface of the munition. Therefore, the residual volumes listed should be increased somewhat to allow for the agent simulant which could not be recovered. For example, a film thickness of 0.01 mm would result in calculated volumes of 0.4, 1.0 and 1.7 ml for the 105mm, 155mm and 8 inch munitions respectively.

c. During a run, the pressure of the air supplied to the pump varied from 60 to 80 psi. The degree of variance depended upon the total pumping time. Obviously, for a given system, flow rate will vary with air pressure. For water at a 10 ft discharge head, the pump is rated at 115 gpm at 80 psi and 105 gpm at 60 psi. This is approximately 8% difference in flow rates. However, these are steady state conditions, while ours were essentially non-steady state conditions. Although the effect of varying pressure on reproducibility of test date is unknown, it is estimated to be less than 8%.

d. During the tests it was noted that the diaphragm pump, while not in operation, held an estimated 8.5 liters of liquid. This was reduced to 4.6 liters by operating the pump for approximately 5 minutes. Additional pumping did not appear to produce any further decrease. This must be considered for the final design of the drain station.

## CONCLUSIONS/RECOMMENDATIONS

1. Total cycle time of the drain station is dependent, to a large extent, upon the volume of agent permitted in the munition after completion of the drain cycle. For cycle times of 40, 90 and 100 seconds for the 105mm, 155mm and 8 inch munitions, the maximum expected volume of agent is 7 ml. To obtain this, the drain tube must be centrally located and touching the bottom of the munition.

2. Total cycle time of the rinse station is 29, 40 and 67 seconds for the 105mm, 155mm and 8 inch munitions respectively.

3. **The control circuit of the final design of the drain system should include liquid sensors in both the munition and drain line near the pump. As an additional control feature, a time delay mechansim would further reduce the possibility of incomplete drainage. The final design should also include provision for decontamination of the system in event of system failure. Also, the air supply line should include an agent trap in event of pump failure and back pressure occurring due to decontamination reactions.**

## Appendix 1

### Test Data

15 Aug 73: Munitions filled with $H_2O$, time to drain and residual volume of $H_2O$ measured.

$V_{155}$ = 4,210 ml  $V_{105}$ = 1,250 ml  $V_8$ = 10,820 ml

| Run # | Munition | Pump Time (sec) | $V_R$ (ml) | Remarks |
|---|---|---|---|---|
| 1 | 155mm | 13 | 17 | $V_R$ meas. by inverting munition |
| 2 | 155mm | 13 | 16 | |
| 3 | 155mm | 20 | est. 1 ml | No test, $H_2O$ overflow @ catch tank |
| 4 | 155mm | 30 | 3 | Pump control valve manually held on |
| 5 | 105mm | 5 | est 1 ml | Only few drops recovered |
| 6 | 105mm | 4 | est. 1 ml | Only few drops recovered |
| 7 | 8" | Approx 40 | - | No test, $H_2O$ overflow @ catch tank |
| 8 | 8" | 36 | 9 | $V_R$ removed by syringe |
| 9 | 8" | 35 | 8 | |
| 10 | 155mm | 20 | 16 | No test - 8" drain tube used in lieu of 155mm tube |
| 11 | 155mm | 19 | 10 | |
| 12 | 155mm | 30 | 4 | Pump control valve held on manually |
| 13 | 105mm | 10 | 5 | Air press to pump varied 60-85 psi |
| 14 | 105mm | 10 | 6 | |
| 15 | 105mm | 10 | 5 | |

16 Aug 73: Tests using 62% wt glycerin to simulate VX @ 70°F

Munition filled to calculated agent vol, drained and $V_R$ removed by syringe. Prior to test, pump was drained - as much as possible,

$V_{155}$ = 2950 ml, $V_{8''}$ = 6580 ml

| Run # | Munition | Time (sec) | $V_R$(ml) | Remarks |
|---|---|---|---|---|
| 1 | 155mm | 13 | 10 | Drain tube immersed 12-5/8" air 70-80psi |
| 2 | 155mm | 29 | 8 | Air press = $P_A$ = 60-65 psi |
| 3 | 155mm | 30 | 8 | $P_A$ = 75-80 psi. Pump holds 1-1-1/2 gal |
| 4 | 8" | 50 | 7 | $P_A$ = 65-80 psi. Drain tube immersed 15-3/4". Actual munition drain time* = 1 gal |
| 5 | 8" | 70 | 5 | $P_A$ = 60-80 psi $d_t$ = 16 sec LL sensor not funct. |
| 6 | 8" | 21 | 35 | LL removed, cleaned & replaced- apparently not to same level. $d_t$ = 16 sec |
| 7 | 8" | 34 | 8 | LL moved to apparent new level $d_t$ = 16 sec |

* The time at which 99% of the liquid had been drained and the drain tube began filling with air. Hereafter referred to as $d_t$.

20 Aug 73: Tests using 16% wt $CaCl_2$ to simulate GB @ 70°F
Munitions filled to calcaulated agent vol, drained &
$V_R$ removed by syringe. Prior to test approx 400 ml $H_2O$
drained from pump.

$V_{105mm}$ = 666 ml, $V_{155mm}$ = 2700 ml, $V_{8"}$ = 6030 ml

| Run # | Munition | Pump Time(sec) | $V_{R(ml)}$ | Remarks |
|---|---|---|---|---|
| 1 | 105mm | 4-1/2 | 3-1/2 | $d_t$ = 2-3 sec. Drain tube inner 5-1/2" |
| 2 | 105mm | 4-1/2 | 5-1/2 | $d_t$ = 2-3 sec. |
| 3 | 105mm | 4 | 7 | Pump filled with 1-1-1/2 gal prior to run $d_t$ = 2-3 sec |
| 4 | 105mm | 6 | 5 | $d_t$ = 2-3 sec |
| 5 | 105mm | 5 | 5 | $d_t$ = 2-3 sec |
| 6 | 105mm | 10 | 6-7 | $d_t$ = 2-3 sec. Manual control of LL |
| 7 | 155mm | 39 | 5 | $d_t$ = 6 sec |
| 8 | 155mm | Approx 60 | est 1 ml | $d_t$ = 6 sec |
| 9 | 155mm | off | -- | $d_t$ = 6 sec |
| 10 | 155mm | 30 | 3 | $d_t$ = 6-7 sec. LL not oper. Pump time selected prior to run |
| 11 | 155mm | 50 | 3 | $d_t$ = 6-7 sec |
| 12 | 8" | 30 | 5 | $d_t$ = 13-14 |
| 13 | 8" | 40 | 3 | $d_t$ = 12-13 |
| 14 | 8" | 50 | est 2 ml | $d_t$ = 12-13 |
| | 8" | - | - | 10,820 ml $H_2O$ for rinse $d_t$ = 21-22 sec |

58

27 Aug 73: Tests using 71% wt glycerin to simulate VX @ 40°F. Munitions filled to calculated agent vol, drained and $V_R$ removed by syringe. Prior to test approx. 400 ml $H_2$) drained from pump.

| Run # | Munition | Simulant Vol (ml) | Pump* Time (sec) | $V_R$(ml) | Remarks |
|---|---|---|---|---|---|
| 1 | 155mm | 2950 | 15 | 16 | $d_t$ = 7-1/2 sec |
| 2 | 155mm | 2950 | 25 | 12 | $d_t$ = 7-1/2 sec |
| 3 | 155mm | 2950 | 35 | 6 | $d_t$ = 8 sec |
| 4 | 155mm | 2950 | 45 | 3 | $d_t$ = 8 sec |
| 5 | 8 in | 3800** | 30 | 7 | $d_t$ = 10-1/2 sec |
| 6 | 8 in | 3700 | 20 | 15 | $d_t$ = 9-1/2 sec |
| 7 | 8 in | 3600 | 40 | 5 | $d_t$ = 9 sec |
| | 8 in | 10820($H_2O$) | -- | -- | $d_t$ = 22 sec - system rinse |

* Pump time controlled manually

** Insufficient simulant to fill to predicted agent volume of 6580 ml

At test completion, an estimated 8490 ml remained in system. Of this, 3900 ml was removed by operating the pump. Estimated volume remaining in pump: 4590 ml.

K·39

# APPENDIX 2

## AGENT AND SIMULANT AGENT PROPERTIES

| Agent Simulated | Simulant | Agent Properties | | Simulant Properties | |
|---|---|---|---|---|---|
| | | Viscosity (CP) | SP.GR. | Viscosity | SP.GR. |
| VX at 40°F | 71%(wt) glycerin at 70°F | 26.0 | 1.03 | 26.5 | 1.18 |
| VX at 70°F | 62%(wt) glycerin at 70°F | 12.0 | 1.01 | 12.5 | 1.16 |
| VX at 90°F | 56%(wt) glycerin at 70°F | 8.0 | 1.005 | 8.3 | 1.14 |
| GB at 40°F | 20%(wt) sucrose at 70°F | 2.0 | 1.12 | 1.95 | 1.08 |
| GB at 70°F | 16%(wt) calcium chloride at 70°F | 1.6 | 1.1 | 1.6 | 1.14 |
| GB at 90°F | 7%(wt) calcium chloride at 70°F | 1.2 | 1.08 | 1.2 | 1.06 |
| HD at 70°F | 20%(wt) magnesium sulfate at 70°F | 4.5 | 1.25 | 6.5 | 1.27 |

**TEST REPORT**

**FOR**

**BB #18 PULL DRAIN AND RINSE (PDR)**

**SIMULANT AGENT DRAIN TESTS**

**TEST NO. CAMDS 18-3**

**MAY 1975**

| | |
|---|---|
| **PREPARED BY:** | **REVIEWED BY:** |
| **A. J. FITZGERALD** | **LEONARD M. LOJEK** |
| **Project Engineer** | **Chief, Testing Section** |
| | **JAMES W. CAULLER** |
| | **Chief, Engineering Office** |

**APPROVED BY:**

**JOHN K. BARTEL**
**Associate System Manager**

**Chemical Agent Munition Disposal System**
**Demil/Disposal Office**
**Edgewood Arsenal**
**Aberdeen Proving Ground, Maryland 21010**

ABSTRACT

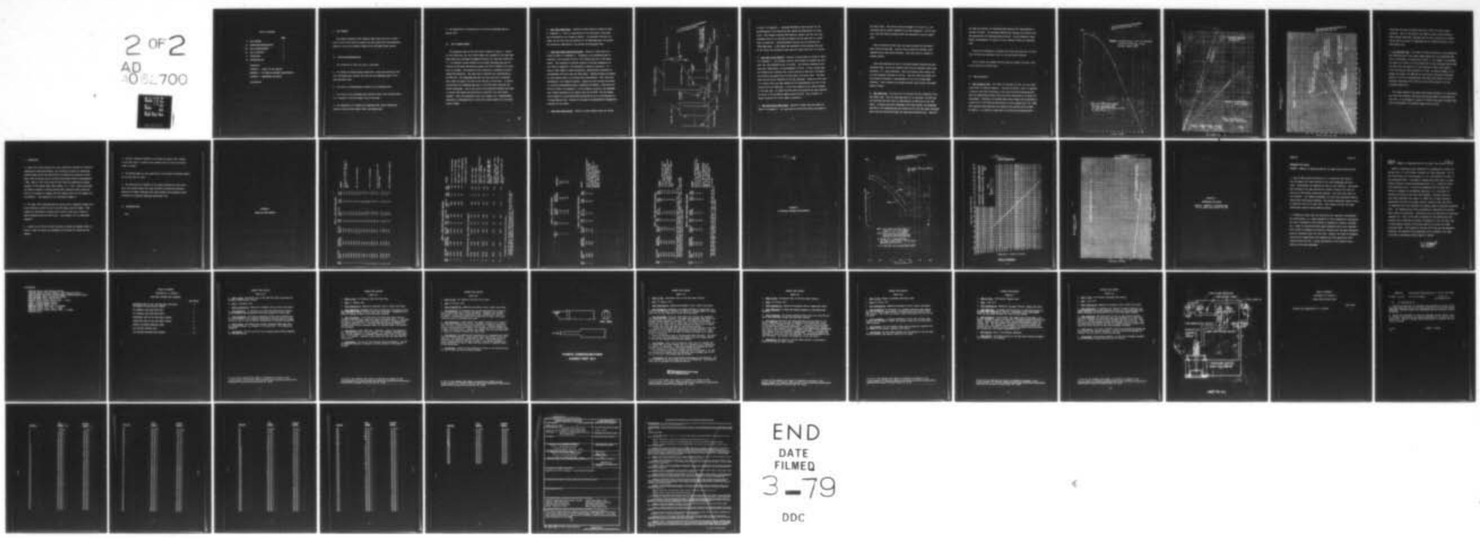
1. Background. Using agent simulants, previous drain tests (test report No. CAMDS 18-2) demonstrated that the projectile agent drain station design was capable of meeting the processing rates scheduled for the Pull, Drain and Rinse System. The "worst case" in the previous tests was simulant VX at 40°F. Due to the rapid increase in viscosity of VX with decrease in temperature and the possibility of processing VX projectiles at temperatures as low as -10°F, additional drain tests were deemed necessary.

2. Summary of Test Results. Results of these tests, performed at Edgewood Arsenal during Feb 75, demonstrate that the present design of the agent drain station is more than adequate for satisfactory performance at these extreme conditions.

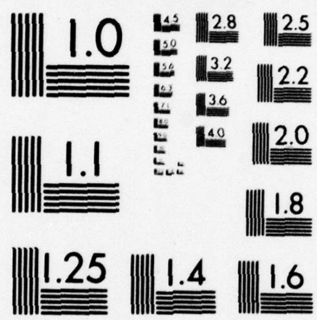
AD-A062 700 OFFICE OF THE PROJECT MANAGER CHEM DEMILITARIZATION I--ETC F/G 19/1
DEMILITARIZATION PLAN OPERATION OF THE CHEMICAL AGENT MUNITIONS--ETC(U)
MAR 77

UNCLASSIFIED DRCPM-DRD-TR-77020 NL

2 OF 2
AD
A062700



END
DATE
FILMED
3-79
DDC




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

## TABLE OF CONTENTS


| | | Page |
|---|---|---|
| I. | TEST PURPOSE | 1 |
| II. | OBJECTIVES/DETERMINATIONS | 1 |
| III. | TEST ACCOMPLISHMENTS | 2 |
| IV. | TEST EVALUATION | 6 |
| V. | CONCLUSIONS | 8 |
| VI. | RECOMMENDATIONS | 9 |

APPENDICES

APPENDIX 1 - TABLES OF TEST RESULTS

APPENDIX 2 - VX PHYSICAL PROPERTY RELATIONSHIPS

APPENDIX 3 - MEMORANDUM FOR RECORD

DISTRIBUTION

## I. TEST PURPOSE.

The primary purpose of this simulant agent drain test was to determine if VX at -10°F could be removed from the projectiles using apparatus similar to that of the present design of the PDR agent drain station.

## II. OBJECTIVES/DETERMINATIONS.

The objectives of this test were to determine:

A. The effect of varying liquid viscosities, suction and discharge line size, discharge head, and air flow rate (to the diaphragm pump) on the pump discharge rates.

B. The effect of decontamination liquids on the diaphragm pump.

C. The effect on the diaphragm pump operation using a fast opening valve, i.e., solenoid, in the air supply line to the pump.

D. The feasibility of flushing the diaphragm pump, while inoperative, using the Central Decon Supply (CDS) centrifugal pump.

E. The feasibility of filtering the oil from the diaphragm pump air exhaust line.

## III. TEST ACCOMPLISHMENTS.

The apparatus used for the flow tests is shown in Figure 1. Except for the flush test, the test liquid supply was contained in the sump tank. These tests were performed at Edgewood Arsenal, MD, Bldg 5354 during Feb 75. All metallic wetted surfaces of the Wilden diaphragm pump and all surfaces of the sump tank had been coated with Rowe's EPOLOID 5-G-5 paint prior to testing. The purpose of this coating is to minimize corrosion during PDR operations. The sump tank is scheduled for installation at the PDR site. The diaphragm pump used in these tests has an aluminum body, while the pump to be used in the PDR has a SS-316 body. It should be noted that the diaphragm pump has a 2 inch NPS inlet (suction) and outlet (discharge). Due to the size of the projectile opening, the drain or suction tube within the projectile is limited to 1/2 inch inside diameter. This size limitation, plus cost, weight, etc. considerations resulted in a discharge line of 11/16 inch inside diameter for the drain station design.

A. Pump Tests Using Water. Results of these tests are listed in Table 1 of Appendix 1. Prior to installation of the flow meter, flow rates were determined by the volumetric method. As previously observed, the higher the air flow rate and pressure to the diaphragm pump, the greater the pulsations transferred to the suction and discharge lines.

B. Pump Tests Using Glycerin Solutions. Results of these tests are listed in Table 2 of Appendix 1. According to the referenced data of Appendix 2, the viscosity of VX at -10°F varies from 155 to 320 centistokes. (The variation of specific gravity of VX with temperature is also shown in Appendix 2 for conversion to absolute viscosity.) To obtain a wide range of liquid viscosities, glycerin-water solutions at approximately 65°F were used for these tests. Adequate mixing was assured by recirculation prior to and during flow measurements. Flow rates were determined by the volumetric method. Samples of each solution were taken for viscosity measurements using a Brookfield Viscometer. These data are listed in Table 3 of Appendix 1. At the highest viscosity, the diaphragm pump stopped operating at air supply less than 10 SCFM. The air piston valve stopped in the position which permitted the air to flow directly to the pump exhaust port. Restart of the pump was accomplished by momentarily stopping the air supply.

C. Pump Tests Using $Na_2CO_3$. Results of these limited tests are listed

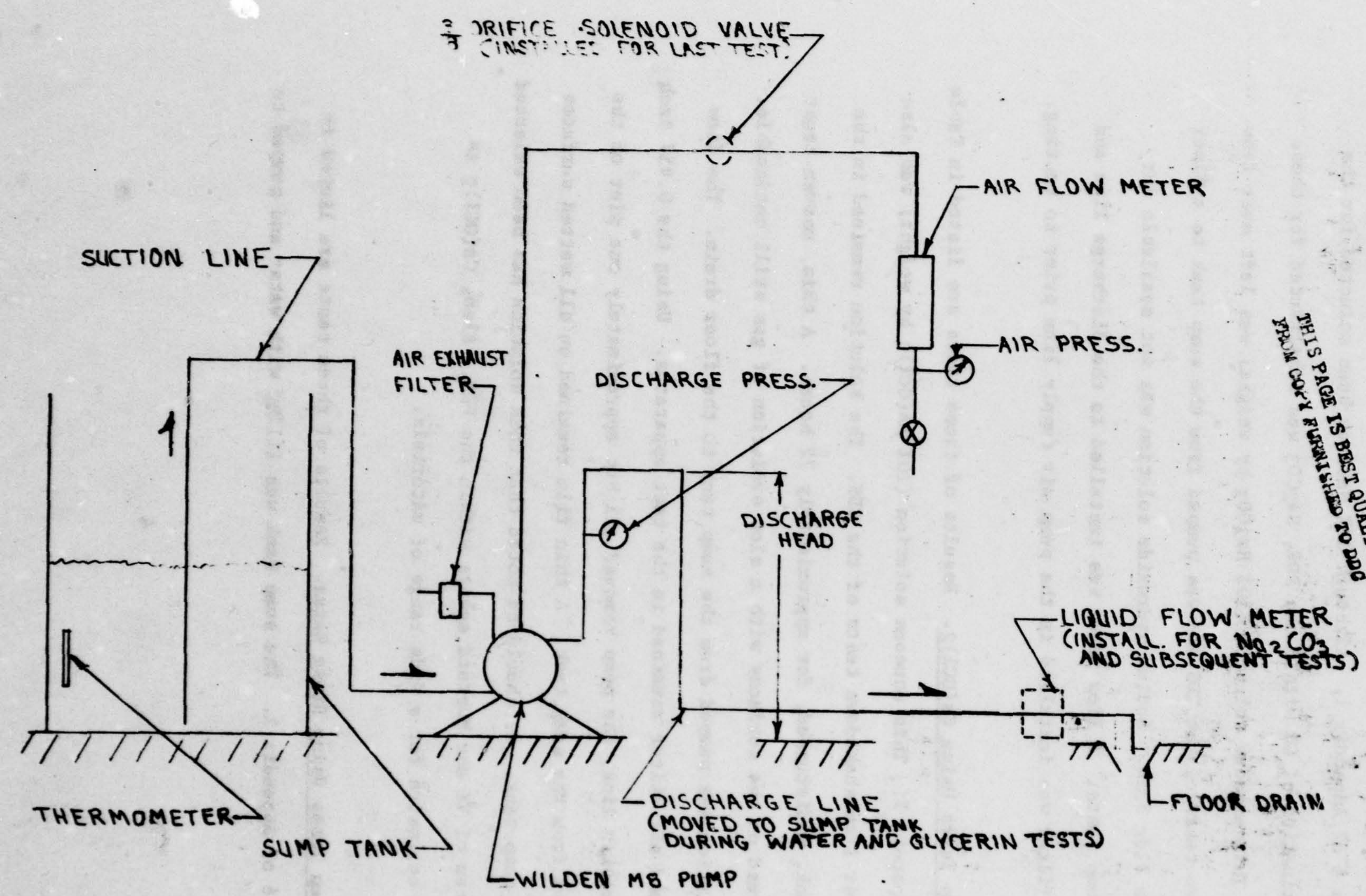



FIGURE 1. TEST APPARATUS

in Table 4 of Appendix 1. Although 18% NaOH as been selected for the decontamination of GB within the PDR, $Na_2CO_3$ was substituted for these tests. This aqueous solution (10% $Na_2CO_3$ by weight) was left over from shakedown tests of the CDS and was pumped from the sump tank to a floor drain in Bldg 5354. Sodium hydroxide solution was not available for these pump tests. A flow meter was installed in the discharge line and an air filter was installed in the pump air supply line prior to testing.

D. Pump Tests Using $Ca(OCl)_2$. Results of these tests are listed in Table 5 of Appendix 1. This aqueous solution (10% $CA(OCl)_2$ by weight) was also left over from shakedown tests of the CDS. The solution remained in the sump tank, undisturbed, for approximately 72 hours. A thin, uneven crust had formed on the surfaces with a slow evolution of gas still noticeable. The solution was pumped from the sump tank to the floor drain. The flow meter and air filter remained in the test apparatus. Using the 0.957 inch I.D. suction line, the pump removed all but approximately one pint of the solution from the sump tank. A thin film remained on all wetted surfaces of the sump tank. It should be noted that this solution has been selected for decon of VX and Mustard agents within the PDR. Also, $Ca(OCl)_2$ is highly corrosive for a wide range of materials.

E. Pump Tests Using Rinse Water. Results of these tests are listed in Table 6 of Appendix 1. The sump tank was filled with water and pumped to



K-108

the floor drain. The suction line was changed to 1/2 inch I.D., the flow meter and air filter remained in the test apparatus. For the last run a 3/8 inch orifice solenoid valve was installed in the air supply line.

With the smaller suction line, the pump suctioned all noticeable water from the sump tank. The thin film, previously observed, still remained on the tank wetted surfaces. This film could be removed by rubbing lightly.

Other than reducing air flow to the pump (thereby reducing the pump discharge rate), use of the solenoid valve did not adversely effect pump operation, i.e., high pulsations. With the solenoid valve closed, the air line pressure increased to 100 psi. When the valve was opened, the line pressure decreased to approximately 50 psi and the pump began operation. This procedure was repeated several times without noticeable adverse effects.

F. <u>Pump Flush Test</u>. For this test the suction line was connected to the CDS supply pump. With the diaphragm pump not in operation, the CDS pump was activated and flow rates of approximately 20 GPM noted at the flow meter. To assure that both diaphragms were being flushed, the discharge manifold of the diaphragm pump was removed and the CDS pump again activated. Water flow was observed through both diaphragm discharge ports. When the



61

K-109

CDS pump was stopped, the diaphragm pump remained full (approximately 3 gallons) of water. The discharge manifold was replaced, the suction line disconnected and the diaphragm pump activated. During subsequent disassembly, approximately 1/2 gallon of water remained within the diaphragm pump.

There was no evidence of corrosion and unlike the sump tank, the thin white film was not observed on any of the pump wetted surfaces.

The air filter was removed from the pump air exhaust line and a film of oil noted in the filter bowl.

## IV. TEST EVALUATION.

A. <u>High Viscosity Flow</u>. The effect of viscosity on flow, for the conditions noted, is shown by Figure 2. The data in Tables 2 and 3 of Appendix 1 indicate that small variations in line restriction and discharge head does not significantly effect flow rates with viscosities at or above 100 centistokes. Therefore, the present agent drain design can be expected to suction VX at -10°F from the projectiles at rates ranging from 5 to 7 GPM. This munition drain time data are compared with previous data as shown by Figure 3. It should be noted that at viscosities approaching 1000

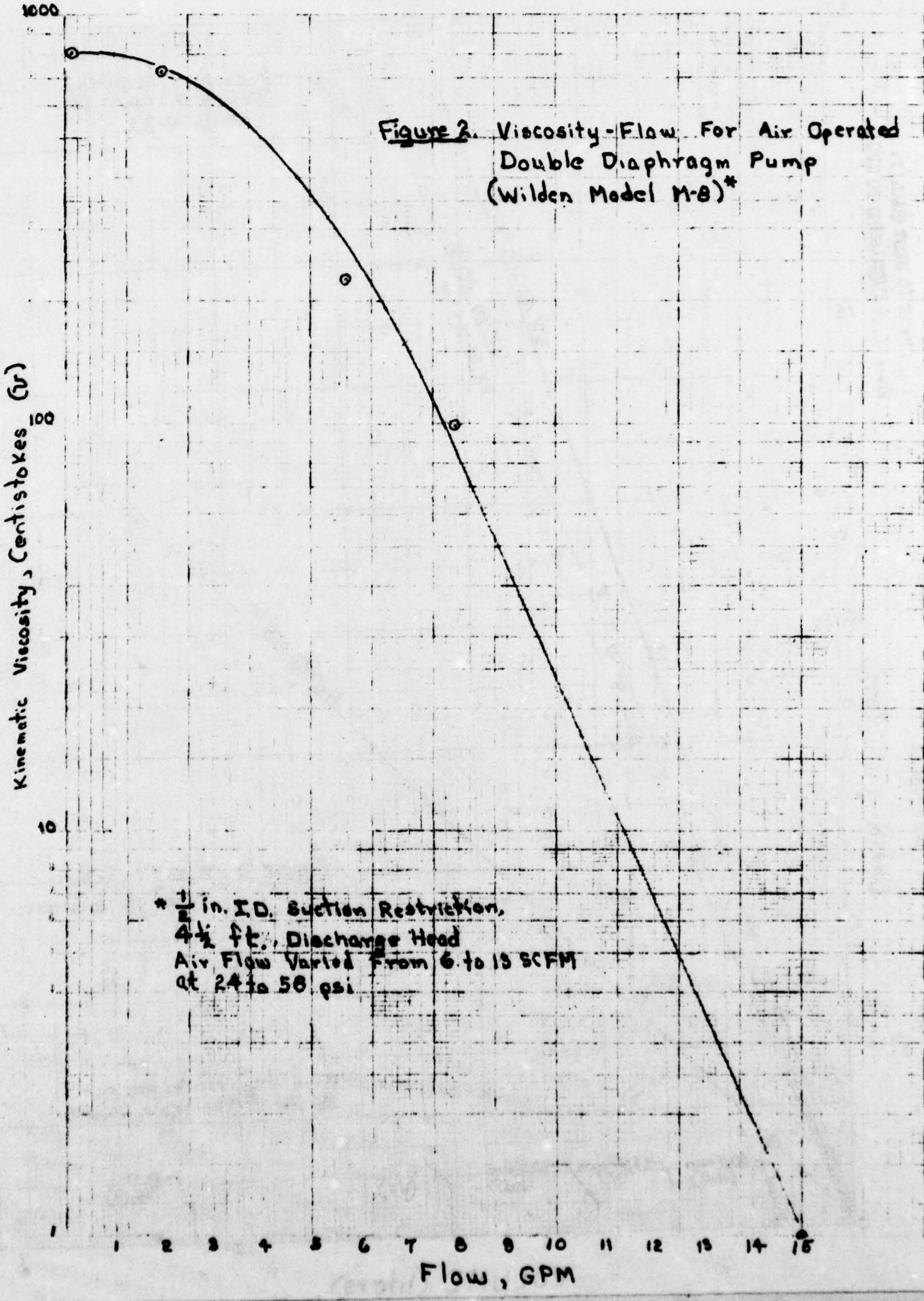


Figure 2. Viscosity-Flow For Air Operated Double Diaphragm Pump (Wilden Model M-8)*
1000
100
10
1
Kinematic Viscosity, Centistokes (ν)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Flow, GPM
* 1/2 in. I.D. Suction Restriction,
4 1/2 ft., Discharge Head
Air Flow Varied From 6 to 13 SCFM
at 24 to 58 psi

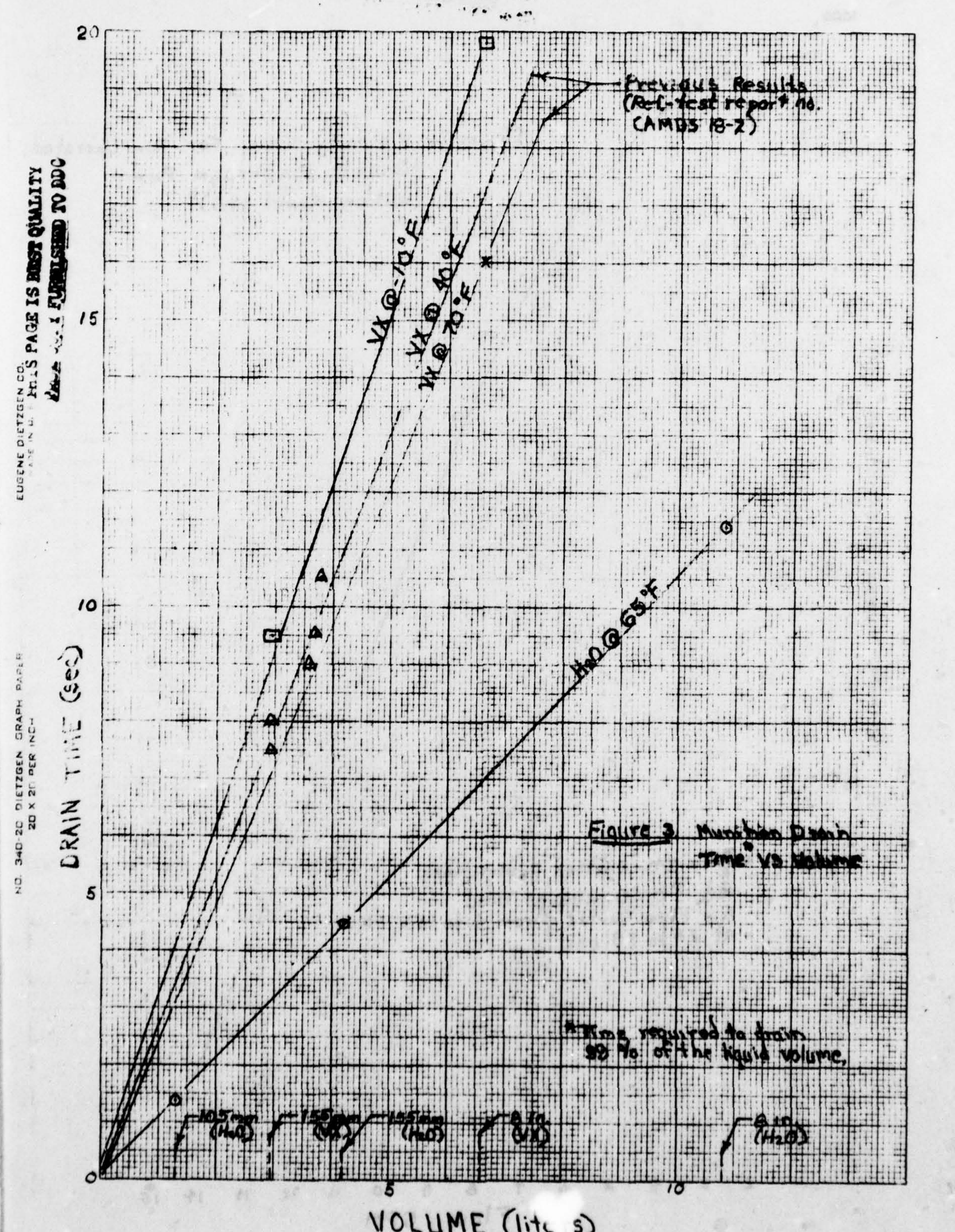



Figure 3 Munition Drain Time* vs Volume

K-113



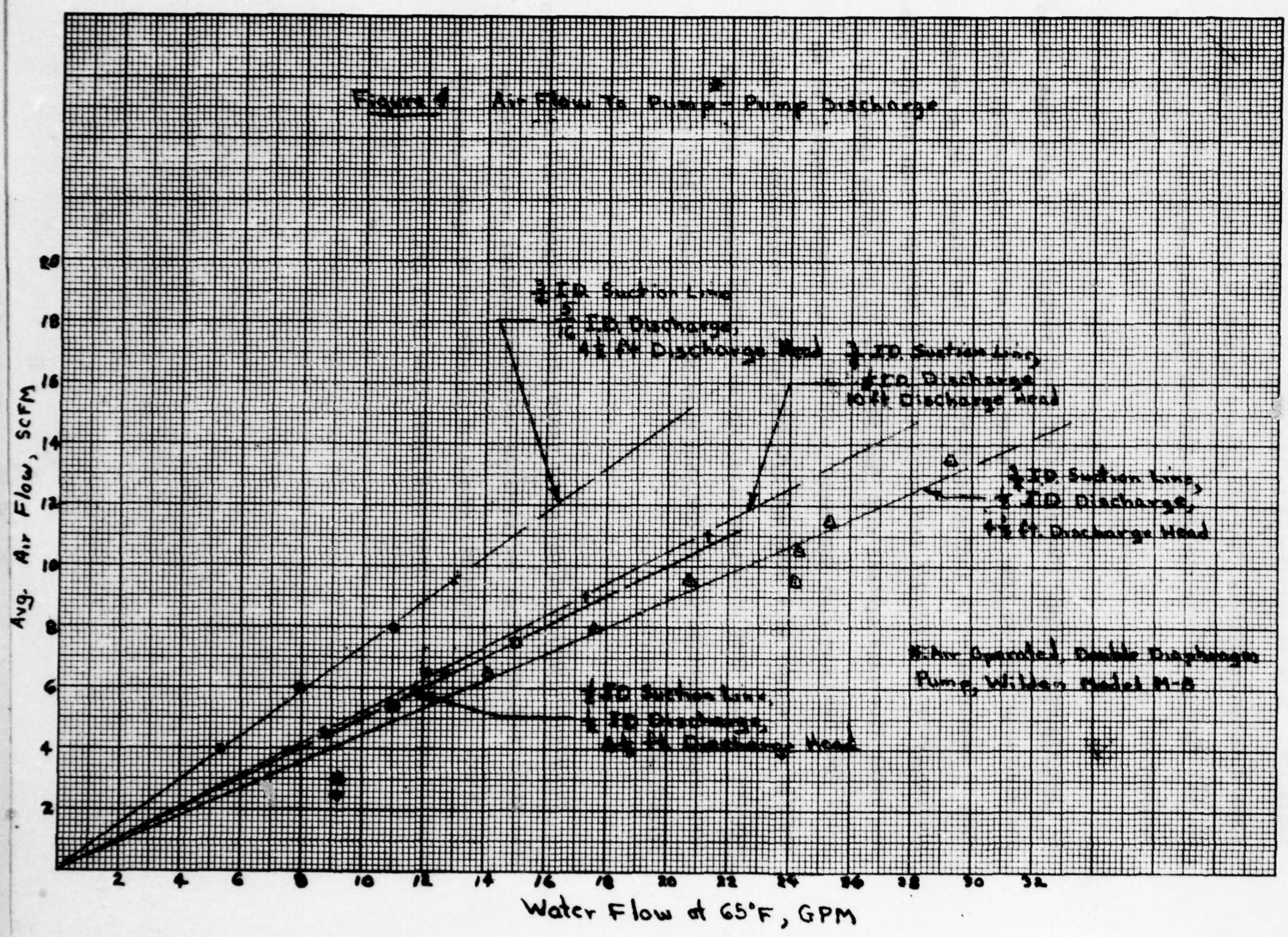


Figure 4 Air Flow To Pump* - Pump Discharge
5/16 I.D. Discharge,
4½ ft Discharge Head
I.D. Suction Line,
10 ft Discharge Head
I.D. Suction Line,
I.D. Discharge,
4½ ft. Discharge Head
I.D. Suction Line,
I.D. Discharge,
Discharge Head
*Air Operated, Double Diaphragm
Pump, Wilden Model M-8
Avg. Air Flow, SCFM
Water Flow at 65°F, GPM
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32

centistokes and pump air supply less than 10 SCFM, the pump stopped operation. This is attributed to the pump air valve, slowly moving at these extreme conditions, becoming fixed in such a position as to permit the air flow to by-pass the diaphragms and be channeled directly to the pump exhaust port.

B. Low Viscosity Flow. The effect of small variations in line restriction and discharge head on flow rates became significant for viscosities less than 10 centistokes, as indicated by Figure 4. For example, at an average air supply of 12 SCFM, 3/4 inch suction and 1/2 inch discharge restrictions, the water flow rate against a 10 foot head was 23 GPM, while against a 4-1/2 foot head the flow increased to 27 GPM. As another example, at an average air supply of 6 SCFM and 3/4 inch suction restriction operating against a 4-1/2 foot discharge head, the water flow through a 1/2 inch discharge restriction was 13 GPM, but only 8 GPM through a 5/16 inch discharge restriction.

The present design of the agent drain piping includes a 1/2 inch suction and 11/16 inch discharge restrictions operating against an anticipated 20 foot head. At an average air supply of 12 SCFM and an agent viscosity less than 10 centistokes, the predicted agent flow is 12 GPM.

## V. CONCLUSIONS.

A. Based on 20 hours operation per day, allowing 20 seconds for projectile indexing and drain head movement, and allowing 35 seconds for minimizing residual agent within the projectiles, the minimum flow required to maintain a rate of 650 per day of 155 mm VX projectiles would be approximately 1 GPM. Even at -10°F, this would be well below the demonstrated pumping capacity of the present agent drain design, i.e., 5 GPM. These conclusions are based on results of testing liquids which simulated agent properties. There is no evidence to suggest that the pumping rates for live agents will be different. (See Appendix III for additional comments.)

B. The agent drain diaphragm pump and piping can be completely flushed with decon solutions or water by use of the CDS supply pump (or equal). This suggests an operational procedure which could be used when a change in agent processed within the PDR occurs. (See Appendix III for additional comments.)

C. Install an air filter in both the pump air supply and exhaust lines to ensure a clean air supply and entrapment of lubricant oil within the air exhaust.

D. Install a pressure regulator in the pump air supply line, outside of the toxic area, to prevent line pressure build up when the solenoid valve is closed.

E. The minimum pump air line constriction, both supply and exhaust should not be less than 1/2 inch.

F. The pump should be operated at air supply pressures and flow rates which will produce agent flow rates dictated by processing schedules. Operation at higher conditions will cause greater line pulsations while decreasing the expected diaphragm operational life.

## VI. RECOMMENDATIONS.

None

## APPENDIX 1

## TABLES OF TEST RESULTS

TABLE 1. PUMP TESTS USING WATER

| RUN NO. | AIR PRESS. (PSI) | DISCHARGE PRESS. (PSI) | AIR FLOW (SCFM) | TEMP (°F) | LIQUID VOL. (GAL) | TIME (SEC) | FLOW (GPM) | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1 | 40-44 | 0-30 | 9-10 | 65 | 23.8 | 59 | 24.2 | 3/4 in. I.D. Suction, 1/2 in. I.D. Discharge, 4 1/2 ft. Discharge Head |
| 2 | 36-41 | 0-27 | 8-13 | 65 | 27.4 | 70 | 24.3 | |
| 3 | 36-40 | 0-28 | 10-13 | 67 | 27.8 | 66 | 25.3 | |
| 4 | 20-29 | 0-20 | 8-11 | 67 | 25.6 | 74 | 20.7 | |
| 5 | 12-15 | 0-10 | 5-8 | 68 | 16.4 | 70 | 14.1 | |
| 6 | 35-53 | 0-34 | 12-15 | 69 | 28.3 | 58 | 29.3 | Max. Air Flow Obtainable |
| 7 | 35-53 | 0-35 | 11-15 | 69 | 20.9 | 43 | 29.2 | |
| 8 | 3-8 | 0-6 | 2-4 | 70 | 22.1 | 144 | 9.2 | |
| 9 | 20-25 | 0-19 | 5-11 | 69 | 16.4 | 56 | 17.6 | |
| 10 | 3-8 | 0-8 | 3-6 | 69 | 15.8 | 109 | 8.7 | |
| 11 | 3-8 | 0-8 | 2-6 | 68 | 7.8 | 89 | 5.3 | 5/16 in. I.D. Discharge |
| 12 | 22-25 | 0-23 | 5-11 | 68 | 11.9 | 65 | 11.0 | |
| 13 | 12-15 | 0-15 | 3-9 | 69 | 6.8 | 52 | 7.9 | |
| 14 | 12-15 | 0-13 | 4-9 | 68 | 15.3 | 72 | 12.7 | 1/2 in. I.D. Discharge, 10 ft. Discharge Head |
| 15 | 20-30 | 0-24 | 7-11 | 68 | 17.0 | 59 | 17.3 | |
| 16 | 36-40 | 0-33 | 9-13 | 69 | 11.4 | 32 | 21.3 | |
| 17 | 14-18 | 0-13 | 4-9 | 70 | 19.2 | 95 | 12.1 | |
| 18 | 4-10 | 0-8 | 2-3 | 70 | 12.4 | 81 | 9.2 | Pump Disassembled and Inspected |

TABLE 2. PUMP TESTS USING GLYCERIN* SOLUTIONS

| RUN NO. | AIR PRESS (PSI) | DISCHARGE PRESS. (PSI) | AIR FLOW (SCFM) | TEMP (°F) | LIQUID VOL. (GAL) | VISCOSITY (CP) | TIME (SEC) | FLOW (GPM) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 25-45 | 0-18 | 10-13 | 65 | .180 | 1005 | 60 | .180 | 1/2 in. I.D. Suction and Dis- |
| 2 | 25-45 | 0-18 | 10-13 | 65 | .180 | 1005 | 60 | .180 | charge, 4 1/2 ft. Discharge |
| 3 | 54-58 | 2-20 | 17-18 | 65 | .182 | 1005 | 60 | .182 | Head, Approx. 5.3 Gal. of 96% |
| 4 | 30-50 | 2-20 | 11-15 | 65 | .172 | 1005 | 60 | .172 | Glycerin. 12 ft Discharge Head |
| | | | | | | | | | Viscosity Sample No. 1 obtained |
| | Pump Flushed with $H_2O$, Then Drained w/o Disassembly | | | | | | | | |
| 5 | 27-48 | 8-40 | 10-13 | 65 | .463 | 905 | 15 | 1.85 | Meas. Flow 3 Times |
| 6 | 18-40 | 6-18 | 9-13 | 65 | .331 | 905 | 15 | 1.32 | Meas. Flow 3 Times |
| 7 | 27-48 | 8-28 | 9-13 | 65 | .463 | 905 | 15 | 1.85 | 3/8 in. I.D., Suction Viscosity sample No. 2 obtained |
| 8 | 27-58 | 8-28 | 8-13 | 67 | .489 | 277 | 15 | 1.96 | Meas. Flow 3 Times |
| 9 | 28-58 | 0-30 | 8-13 | 68 | .476 | 277 | 5 | 5.70 | Add .53 Gal. $H_2O$, Meas. Flow 3 Times, Viscosity sample No.3 obtained. |
| 10 | 28-50 | 0-23 | 8-13 | 69 | .476 | 118 | 5 | 5.70 | Meas Flow 3 Times. Add .53 Gal $H_2O$ Mes. Flow 3 Times Viscosity sample No. 4 obtained |
| 11 | 25-50 | 0-24 | 8-13 | 72 | .662 | 118 | 5 | 7.94 | Pump Flushed with Approx. 200 Gal $H_2O$. |

* Glycerin mfg. by Atlas and rated at 96% purity.

+ At lower air flows, the pump stopped operating with the air passing directly through the pump air piston to the air exhaust port. Restart of the pump was accomplished by momentarily stopping the air flow.

71

K u e

## TABLE 3. VISCOSITY TEST RESULTS

| SAMPLE NO. | TEMP (°F) | SPECIFIC GRAVITY | VISCOSITY CENTISTOKES | CENTIPOISE |
|---|---|---|---|---|
| 1 | 65 | 1.245 | 810 | 1005 |
| 2 | 65 | 1.245 | 726 | 905 |
| 3 | 68 | 1.225 | 226 | 277 |
| 4 | 72 | 1.205 | 98 | 118 |

## TABLE 4. PUMP TESTS USING 10% $Na_2CO_3$

| RUN NO. | AIR PRESS (PSI) | DISCHARGE PRESS (PSI) | AIR FLOW (SCFM) | TEMP (°F) | LIOUID VOL. GAL | TIME (SEC) | FLOW (GPM) | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1 | 37-43 | 0-26 | 7-10 | 65 | 15 | 60 | 15 | 1/2 in. I.D. Suction and Discharge Approx. 200 Gal in Sump tank, 5 ft. Suction Head, 4 1/2 ft. Discharge Head, flow meter Install in Discharge Line, 3/8 NPT Filter Installed in Air Exhaust Line. Flushed with Approx. 200 Gal. $H_2O$. |
| 2 | 20-30 | 0-15 | 5-7 | 65 | 13 | 60 | 13 | |
| 3 | 50-65 | 0-38 | 11-16 | 66 | 15 | 60 | 15 | |

TABLE 5. PUMP TESTS USING 10% $Ca(OCl)_2$*

| RUN NO. | AIR PRESS (PSI) | DISCHARGE PRESS. (PSI) | AIR FLOW (SCFM) | TEMP (°F) | LIQUID VOL. GAL. | TIME (SEC) | FLOW (GPM) | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1 | 35-55 | 0-28 | 10-14 | 65 | 70 | 300 | 14.0 | 0.957 I.D. Suction with 1/2 in. I.D. restriction, 5 ft. Head, 1/2 in. I.D. Discharge with 4 1/2 ft Head, Flow Meter Install. in Discharge line, 3/8 NPT Filter Install. in Air Exhaust Line. |
| 2 | 28-45 | 0-24 | 8-11 | 65 | 13.6 | 60 | 13.6 | |
| 3 | 28-45 | 0-24 | 8-11 | 66 | 13.0 | 60 | 13.0 | |
| 4 | 22-35 | 0-18 | 6-9 | 67 | 13.0 | 60 | 13.0 | |
| 5 | 22-35 | 0-18 | 6-9 | 67 | 12.0 | 60 | 12.0 | |
| 6 | 28-35 | 0-12 | 6-7 | 67 | 12.0 | 60 | 12.0 | |

*The solution was prepared in the CDS system and pumped to the sump tank. The 250 gallon solution remained in the tank, unagitated, for approximately 72 hours. A thin, uneven crust had formed with some evolution of gas still noticeable. Approx. 1 pint of liquid could not be pumped from the tank using the 1in. suction pipe.

TABLE 6. PUMP TESTS USING RINSE WATER*

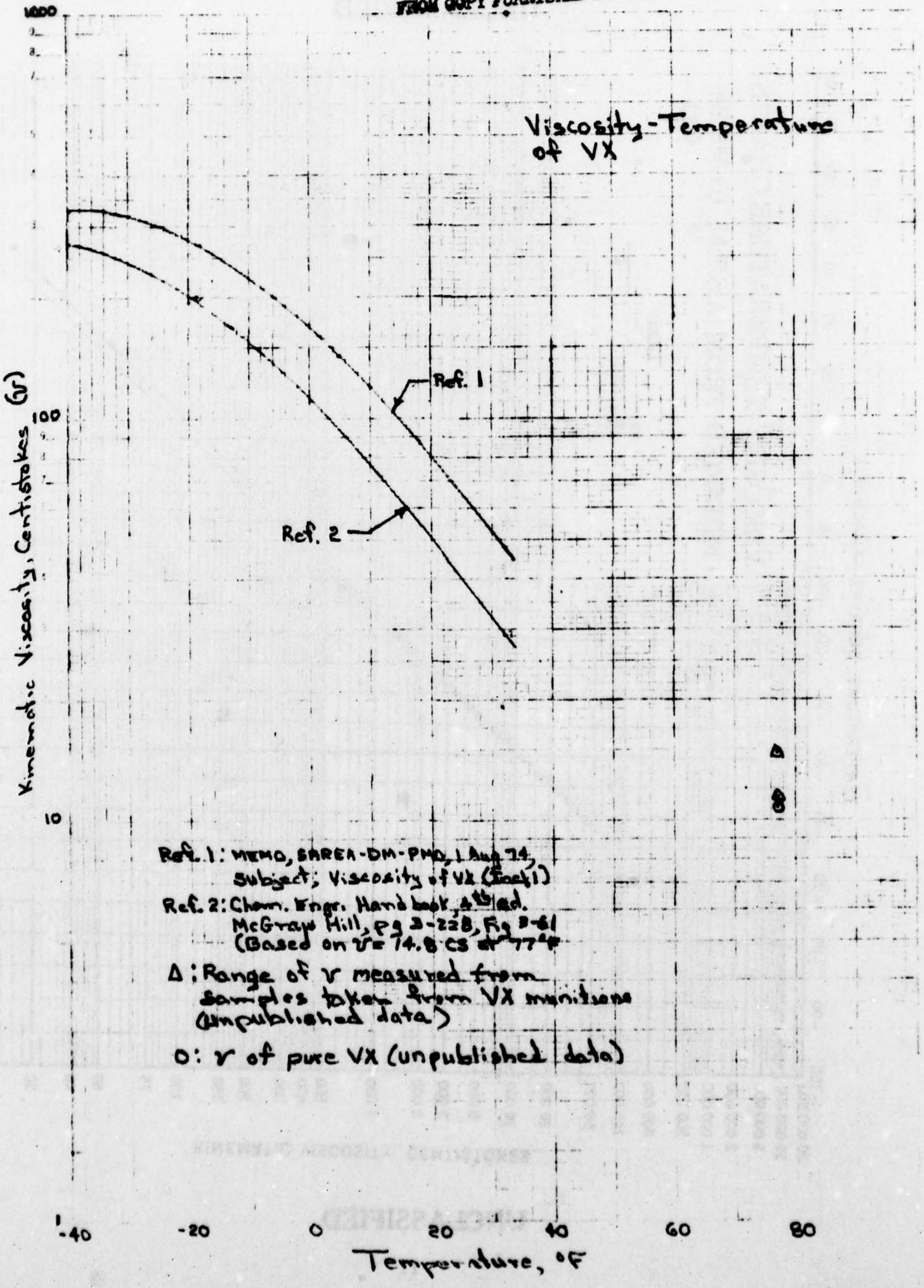
| RUN NO. | AIR PRESS (PSI) | DISCHARGE PRESS. (PSI) | AIR FLOW (SCFM) | TEMP (°F) | LIQUID VOL.GAL. | TIME (SEC) | FLOW (GPM) | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1 | 24-38 | 0-35 | 6-9 | 65 | 15 | 60 | 15 | 1/2 in. I.D. Suction with 10 ft. Head, 1/2 in. I.D. Discharge with 4 1/2 ft. Head Flow Meter and Air Filter remained. |
| 2 | 15-25 | 0-12 | 4-7 | 65 | 11 | 60 | 11 | |
| 3 | 15-25 | 0-12 | 4-7 | 66 | 11 | 60 | 11 | |
| 4 | 25-38 | 0-14 | 5-7 | 65 | 9 | 60 | 9 | 3/8 in. Orifice Solenoid Valve install. in. Air Supply Line. Meas. Flow 3 Times, A thin film of oil was noted in the pump air exhaust filter. |

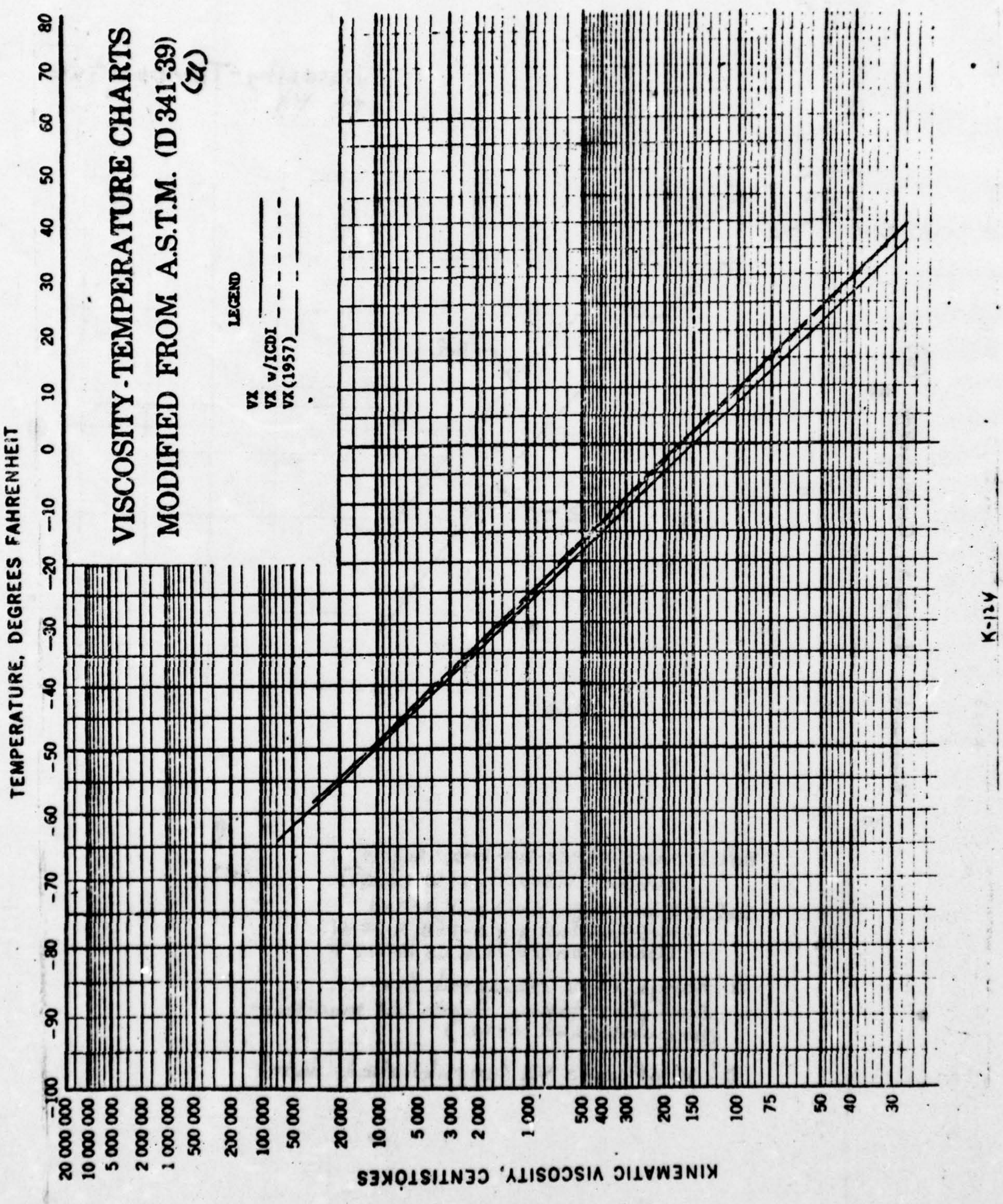
* The sump tank was filled with approx. 250 gallons of water. Using the 1/2 in. I.D. suction line all noticeable water was pumped from the tank. A thin white film remained on the surface of the tank. This film was removed by rubbing lightly.

# APPENDIX 2

# VX PHYSICAL PROPERTY RELATIONSHIPS

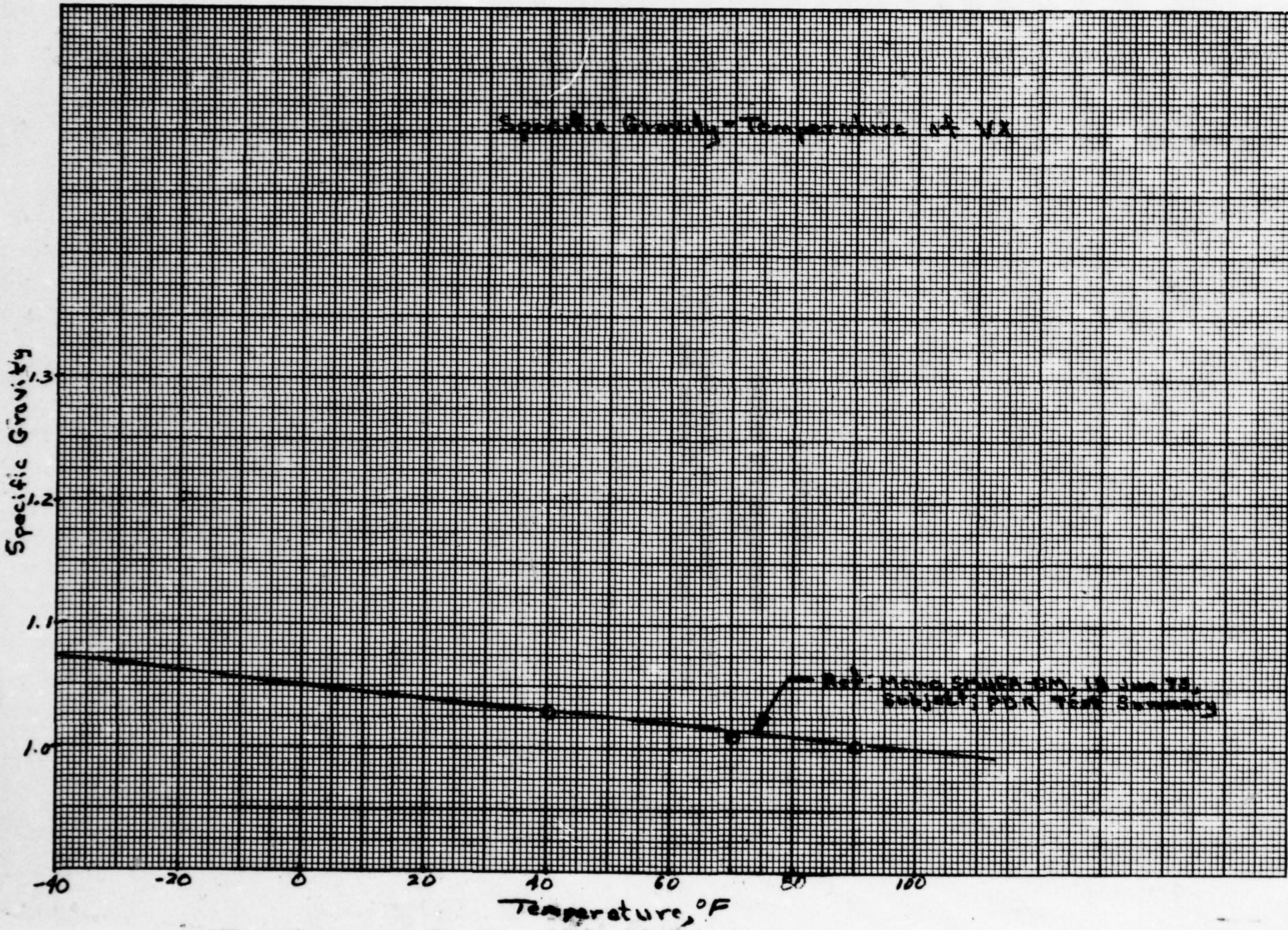
K-123

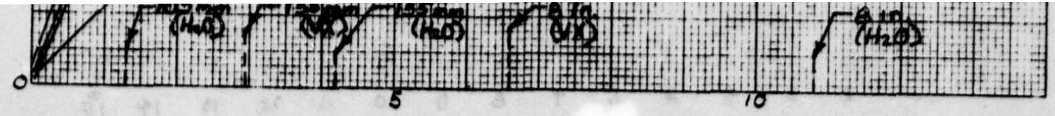

Viscosity-Temperature of VX
1000
100
10
1
Kinematic Viscosity, Centistokes (ν)
Ref. 1
Ref. 2
Ref. 1: MEMO, SAREA-DM-PMD, 1 Aug 74,
Subject; Viscosity of VX (Incl 1)
Ref. 2: Chem. Engr. Handbook, 4th ed.
McGraw Hill, pg 3-228, Fig 3-61
(Based on ν = 14.8 CS at 77°F
Δ; Range of ν measured from samples taken from VX munitions (unpublished data)
O: ν of pure VX (unpublished data)
-40
-20
0
20
40
60
80
Temperature, °F


VISCOSITY-TEMPERATURE CHARTS
MODIFIED FROM A.S.T.M. (D 341-39)
(U)
LEGEND
VX
VX w/ICDI
VX (1957)
TEMPERATURE, DEGREES FAHRENHEIT
KINEMATIC VISCOSITY, CENTISTOKES
K-12V

K-128

K+E 10 X 10 TO ½ INCH 46 1323
7 X 10 INCHES
KEUFFEL & ESSER CO.





VOLUME (lit s)

APPENDIX 3

MEMORANDUM FOR RECORD

Subject: Comments on Diaphragm Pump
For the Agent Drain Station for PDR

K-124

SAREA-DM 30 May 75

MEMORANDUM FOR RECORD

SUBJECT: Comments on Diaphragm Pump For the Agent Drain Station For PDR

1. Data in CRDL Special Publication No. 5-9 dated Dec 1965 indicate that the agents will cause swelling of the Viton diaphragms and valve seats. Unfortunately the magnitude of swell is not indicated. Operational data provided by the pump manufacturer (Wilden) indicate that Viton can swell up to 20% without causing any problems. Data above this figure is not available. The clamping arrangement for these pump components however, should allow even greater swelling. The working temperature range of Viton is listed as -20°F to at least 150°F. This range is broader than agent temperatures expected during CAMDS operations.

2. Flushing the agent pump and piping would not completely decontaminate the drain system, i.e., agent permeation of Viton components is anticipated. The rate of permeation, which depends on temperature, pressure, thickness, etc., cannot be calculated because agent permeation data is not available. This is more of academic than practical interest since the agent permeation would be contained within the toxic area. Further, the level of contamination would be insignificant when compared with that expected at other stations within the PDR. Of more significance is the expected time to failure of the pump diaphragms.

K-122

Results of mechanical tests performed by the manufacturer indicate an average life of $2 \times 10^6$ strokes (flexures) for Viton diaphragms. For the test method used, this was equivalent to $1.54 \times 10^6$ gallons at 50 GPM, or 500 operational hours. A decrease in pumping rate would effect a corresponding increase in expected operational hours, i.e., 5 GPM would effect 5000 operational hours. It should be remembered that the agent drain station is designed for intermittent operation, i.e., 20 seconds for indexing the projectile and drain head movement. Previous projectile drain tests (reference test report no. CAMDS 18-2) of agent simulants demonstrated that 99% of the agent could be removed in less than 10% of the remaining cycle time available for pumping, based on scheduled processing rates. The remaining cycle time is available for minimizing the residual agent within the projectiles. During this time, the pump would be essentially "pumping" air. Thus, if the pump is operated for the maximum pump time available and is adjusted to provide a discharge of 5 GPM, the total time of pump operation during a 20 hour day would be 14.5 hours for 105mm projectile demil. This equates to 345 days of 20 hours per day operation. Obviously, the lifetime of the diaphragms can be increased if the pump time spent in minimizing residual agent is reduced.

A. J. Fitzgerald

A. J. FITZGERALD
CAMDS Engineer

K-178

DISTRIBUTION

SAREA-DM (Chief, Demil/Disposal Office)
SAREA-DM (General Projects Manager, Demil/Disposal Office)
SAREA-DM-CAMDS (Associate Systems Manager, Demil/Disposal Office)
SAREA-DM-CAMDS (Chief, Engineering Office)
SAREA-DM-CAMDS (Chief, Test Section)
SAREA-SA (Chief, Safety Office, Attn: J. Kerr)
AMXDC-T (Program Manager Office)
AMXDC-O (Program Manager Office)
AMXTE-AEO (Chief, AEO, Attn: R. Stevens)
AMXDC-FT (Tooele, Attn: MAJ R. Timpf)
AMXTE-ADS (Chief, Safety Office, Attn: M. Zaugg)
SAREA-DM (File)

K-129

## TABLE OF CONTENTS

## INCLOSURE NO. 11 SECTION 4

## MINE DEMIL MACHINE TEST SUMMARIES


| | Page Number |
|---|---|
| DETONATION TEST OF M23 LAND MINE BODY CONTAINING M48 BURSTER IN DEACTIVATION FURNACE. | 1 |
| M23 CHEMICAL LAND MINE DRAIN TEST | 2 |
| M23 CHEMICAL LAND MINE PUNCH TESTS | 3 |
| OPERATIONAL TEST OF M23 MINE DEMIL MACHINE | 5 |
| OPERATIONAL TEST OF M23 MINE DEMIL MACHINE | 6 |
| REMOVAL OF BOOSTER RETAINING RINGS | 7 |
| M120 BOOSTER PRESSURE TEST | 8 |
| M120 BOOSTER RETAINING RING REMOVER | 10 |

SUMMARY TEST REPORT*

CAMDS 25-1

1. Name of Test. Detonation Test of M23 Land Mine Body Containing M48 Burster in Deactivation Furnace.

2. Date. 17 November 1971.

3. Tests Conducted By. Ammunition Equipment Office, Tooele Army Depot.

4. Test Objective. To determine if an APE 1236 deactivation furnace could withstand the detonation of M48 side bursters in a mine body.

5. Test Procedures. Four mines containing bursters were detonated one at a time inside a cold (unfired) deactivation furnace using a 10 gram charge of Comp C-3 and an electric blasting cap to detonate the burster.

6. Test Results. The furnace was visually inspected after each shot. The furnace retained all fragments of the mine body. The furnace was undamaged.

7. Conclusions. The M23 Land Mine can be demilitarized without removing the M48 side burster.

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

SUMMARY TEST REPORT*

CAMDS 25-2

1. <u>Name of Test</u>. M23 Chemical Land Mine Drain Test.

2. <u>Date</u>. 27 January 1972.

3. <u>Test Conducted By</u>. Ammunition Equipment Office, Tooele Army Depot.

4. <u>Test Objectives</u>. Determine the size of drain hole and amount of pressure required to drain a mine in less than 10 seconds. Determine the amount of residual liquid in the mine after draining.

5. <u>Test Procedures</u>. A 1/4-inch wide x 3/4-inch long drain hole was punched in an inert empty mine body using a prototype punch. A vent hole was made in the opposite side of the mine body with a variable pressure air supply connected to it. The mine body was filled and drained repeatedly using various simulants (water or ethylene glycol) and various air pressures.

6. <u>Test Results</u>. Drain times were: Waterfill, ambient air pressure = 41.5 seconds; Waterfill, 10 psi pressure = 7.0 seconds; ethylene glycol fill, 10 psi pressure = 9.6 seconds; ethylene glycol fill, 12 psi pressure = 3.4 seconds. Residual liquid after each test was less than one fluid ounce.

7. <u>Conclusions.</u> The size of the prototype punch is adequate. Ten psi differential pressure is adequate to drain the mine in less than 10 seconds.

K-133

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

SUMMARY TEST REPORT*

CAMDS 25-3

1. Name of Test. M23 Chemical Land Mine Punch Tests.

2. Date. 29 January 1972.

3. Tests Conducted By. Ammunition Equipment Office, Tooele Army Depot.

4. Test Objective. To determine the optimum configuration of punch to use to punch drain holes in M23 land mines. Parameters are minimum deformation of mine body, minimum punch wear, minimum punch force requirements, fabrication economy and a drain hole at least .188 square inches as used in a previous drain test.

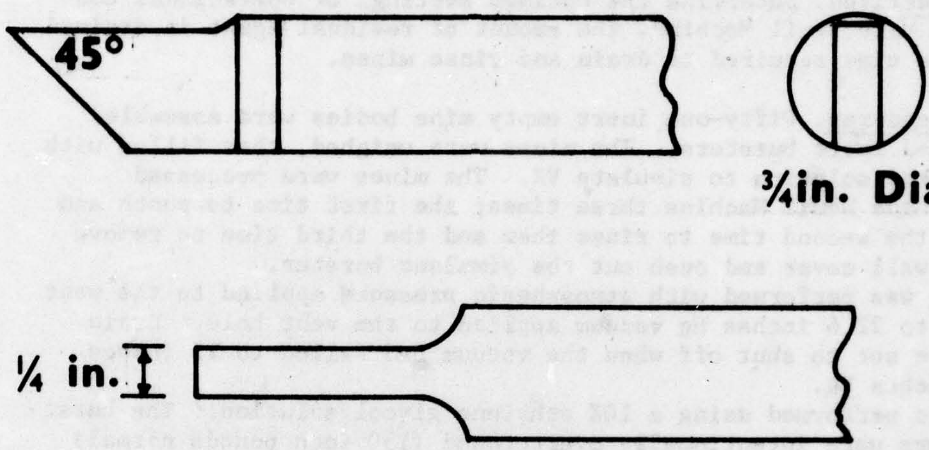
5. Test Procedures. A test fixture was rigged consisting of a clamp to hold the mine, a punch guide block, a hydraulic cylinder to drive the punch rod and a variable pressure hydraulic pump. Eighteen punches of various configurations were tested. All Punches were first tested using a hammer as a drive force. Punches that passed this test were then tested using the hydraulic cylinder for drive force.

6. Test Results. Six punches were rejected due to a combination of punch wear and mine deformation. Seven punches were rejected due to mine deformation. One punch was rejected due to wear. Two punches were rejected because resultant hole was too small. Two punches achieved all design parameters but one of these required grinding of compound angles during fabrication.

7. Conclusions. A punch of the configuration shown on the attached drawing will be used for the Mine Demil Machine.

K-134

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.




**PUNCH CONFIGURATION**

**CAMDS TEST 25-3**

SUMMARY TEST REPORT*

CAMDS 25-4

1. Name of Test. Operational Test of M23 Mine Demil Machine.

2. Date. 25 January 1974.

3. Test Conducted By. Ammunition Equipment Office, Tooele Army Depot.

4. Test Objectives. Determine the optimum settings of operational controls on the Mine Demil Machine, the amount of residual agent in drained mines and the time required to drain and rinse mines.

5. Test Procedures. Fifty-one inert empty mine bodies were assembled with simulated inert bursters. The mines were weighed, then filled with ethylene glycol solution to simulate VX. The mines were processed through the Mine Demil Machine three times; the first time to punch and drain them, the second time to rinse them and the third time to remove the burster well cover and push out the simulant burster.

Draining was performed with atmospheric pressure applied to the vent hole and 21 to 22.6 inches Hg vacuum applied to the vent hole. Drain controls were set to shut off when the vacuum had fallen to 15 inches Hg and 10 inches Hg.

Rinse was performed using a 10% ethylene glycol solution. The burster well covers were intentionally overtorqued (150 inch pounds normal) to 225-380 inch pounds during initial assembly.

6. Test Results. Drain time and residual liquid was 15.1 seconds and 51.4 grams with the drain shutoff set at 15 inches Hg (16.5 seconds and 56 grams at 10 inches Hg). Rinse time averaged 19.3 seconds per mine with an average of 6.4 grams of residual rinse solution.

All the burster well covers, except one that was screwed in too far, were successfully removed with the hydraulic motor pressure set at 600 psi and the motor flow control set for 60 RPM.

7. Conclusions. The Mine Demil Machine operations are satisfactory. The drain shutoff vacuum switch shall be set at 10 inches Hg. The hydraulic motor will be operated at 60 RPM and 600 psi.



*A copy of the compete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

SUMMARY TEST REPORT*

CAMDS 25-5

1. Name of Test. Operational Test of M23 Mine Demil Machine.

2. Date. 14-15 March 1974.

3. Test Conducted By. Ammunition Equipment Office, Tooele Army Depot.

4. Test Objectives. To check the design integrity of the Mine Demil Machine.

5. Test Procedures. Two Hundred simulant-filled mines with live M38 bursters were processed through the Mine Demil Machine.

6. Test Results. The punch and drain operation was successful on all mines. Three failures occurred in removal of the burster well cover. The drive shaft slipped on the motor shaft. The drive shaft was pinned to the motor shaft to prevent recurrence. The hydraulic motor stalled once due to cold hydraulic fluid. A pressure and temperature compensating flow control valve was installed to prevent recurrence. A burster well cover failed to fall off from the removal head. A stripping device was installed to strip the cover from the head. No failures occurred on the last 168 mines. The burster was pushed out of all the mines.

7. Conclusions. The design of the Mine Demil Machine is satisfactory based on the current demil concept.

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

**SUMMARY TEST REPORT***

**CAMDS 25-6**

1. Name of Test. Removal of Booster Retaining Rings

2. Date. 18 October 1974.

3. Test Conducted By. Ammunition Equipment Office, Tooele Army Depot.

4. Test Objectives. To determine if a standard retaining ring removal tool can be used to remove booster retaining rings from plastic cased M38 bursters. Both steel and plastic cased M38 bursters are used in the M23 mines.

5. Test Procedures. A standard expandable collect type retainer ring removal tool was used to remove the retainer rings from ten M38 plastic cased bursters.

6. Test Results. All ten retainer rings were successfully removed without damage to the plastic casing on the burster.

7. Conclusions. The Mine Demil Machine will be designed to use the same booster retainer ring removal device for all mines.

K-138

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

SUMMARY TEST REPORT*

CAMDS 25-7

1. Name of Test. M120 Booster Pressure Test.

2. Date. 6 May 1975.

3. Test Conducted By. Ammunition Equipment Officer, Tooele Army Depot.

4. Test Objective. To assure the M120 booster in land mines would not detonate when subjected to 1000 lbs. compression force, the maximum force the Mine Demil Machine will exert on the burster.

5. Test Procedure. A test fixture was rigged using a barricade, a hydraulic cylinder to apply the force and a variable pressure hydraulic oil supply. Thirty boosters were tested, 20 containing tetryl and 10 containing RDX. The test booster was placed in the barricade under the cylinder ram. The cylinder was extended at low pressure against the burster and the cylinder hydraulic pressure increased until the burster was subjected to 1700 pounds compression force.

6. Test Results. None of the bursters detonated.

7. Conclusions. The design concept of the Mine Demil Machine to remove M120 boosters is a safe design.

K-39

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.

90

SUMMARY TEST REPORT*

CAMDS 25-8

1. Name of Test. M120 Booster Retaining Ring Remover.

2. Date. 7 May 1975.

3. Test Conducted By. Ammunition Equipment Office, Tooele Army Depot.

4. Test Objectives. To determine the hydraulic pressure regulator settings required on the collet expander cylinder for the pilot model ring remover designed and fabricated for use on the Mine Demil Machine.

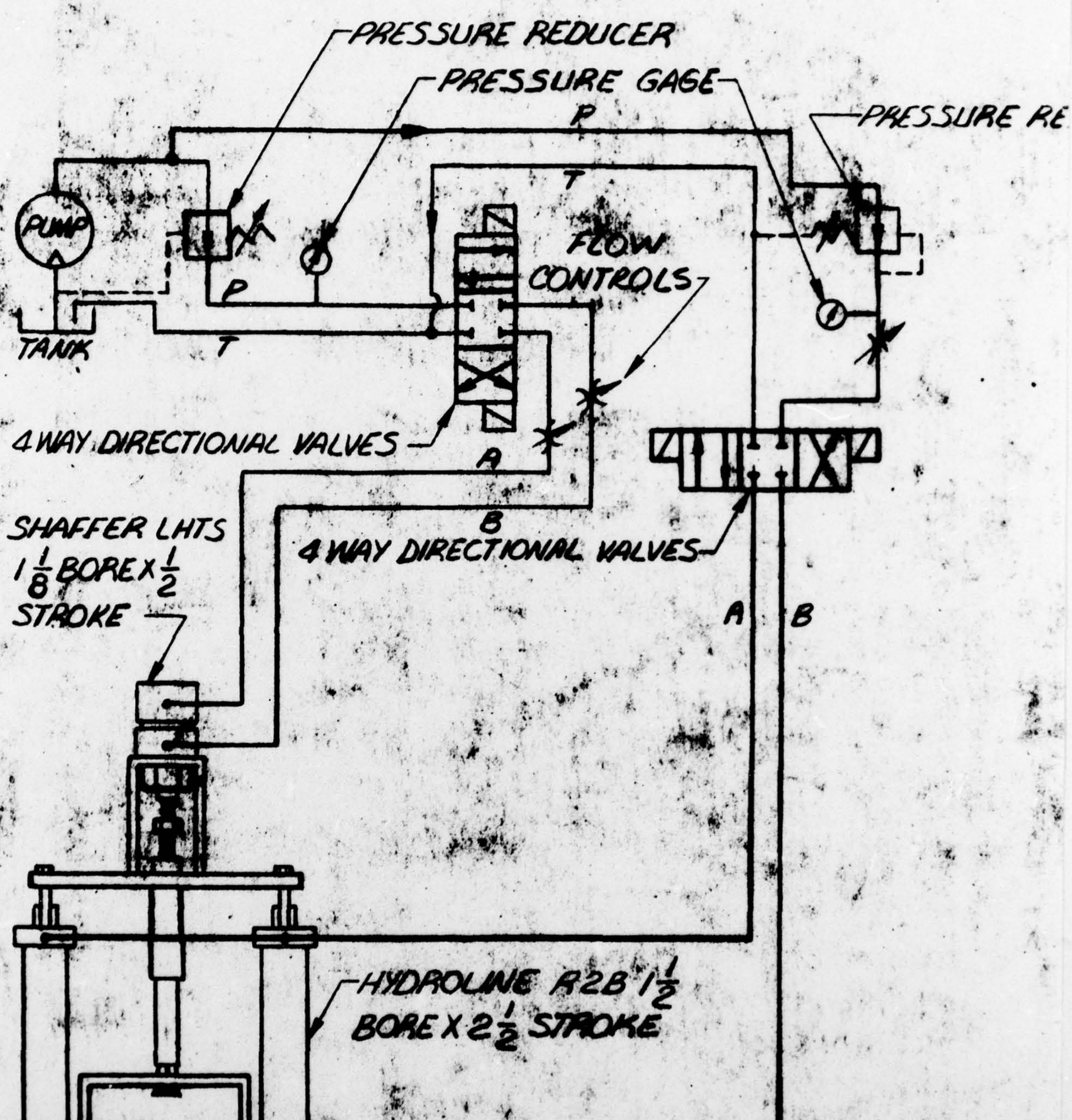
5. Test Procedures. The test setup is shown on the attached drawing. Inert M120 boosters and retaining rings were installed in 20 inert M38 bursters. Pressure to the two pull cylinders was set at 350 psi. Pressure to the collet expander cylinder was initially set at 350 psi. The retaining rings were pulled from all 20 bursters at various pressure settings from 350 to 550 psi on the collet expander cylinders.

6. Test Results. The twenty retaining rings were successfully pulled the first time at all pressure settings. All four collet jaws gripped the retainer ring the best at the 550 psi settings.

7. Conclusions. The pressure regulator for the collet expander cylinder on the Mine Demil Machine should be set at 550 psi.

K-140

*A copy of the complete test report is available on request to the Project Manager for Chemical Demilitarization and Installation Restoration, DRCPM-DRD-TM, Aberdeen Proving Ground, MD 21010.




CAMDS TEST 25-8

# TABLE OF CONTENTS

## INCLOSURE NO 11 SECTION 5

## MORTAR DEMIL MACHINE TESTS


| | Page number |
|---|---|
| DEFUZING AND DEBURSTERING OF 4.2 MORTAR | 1 |


K-143

AMXTE-AEO Defuzing and Deburstering of 4.2 Mortar (HC Smoke)

XX THRU: Ch, AEO Ch, R T & M Branch 27 Mar 72
Mr Wilson/cb/2649

To: Ch, Engineering Br.

1. Testing was conducted to determine torque required to unscrew the M8 fuze from the mortar body and the torque required to unscrew the burster from fuze. 198 each rounds were disassembled and data obtained is shown on Incl #1.

2. During the disassembly of items the following was also noted. Three to six turns were required for complete separation of the fuze from the mortar body. Twelve to sixteen turns were required to separate the fuze from the burster.

1 Incl
as

JOSEPH L. PALMER

K-144

| ITEM NO. | FUZE TORQUE Ft Lb | BURSTER TORQUE Ft Lb |
|---|---|---|
| 1 | 8 Ft Lb | 2 Ft Lb |
| 2 | 1 Ft " | 20 Ft " |
| 3 | 12 Ft "" | 29 Ft " |
| 4 | 12 Ft " | 30 Ft " |
| 5 | 7 Ft " | 20 Ft " |
| 6 | 20 Ft " | 20 Ft " |
| 7 | 15 Ft " | 19 Ft " |
| 8 | 14 Ft " | 12 Ft " |
| 9 | 20 Ft " | 15 Ft " |
| 10 | 25 Ft " | 30 Ft " |
| 11 | 20 Ft " | 20 Ft " |
| 12 | 12 Ft " | 5 Ft " |
| 13 | 20 Ft " | 30 Ft " |
| 14 | 28 Ft " | 30 Ft " |
| 15 | 30 Ft " | 30 Ft " |
| 16 | 20 Ft " | 40 Ft " |
| 17 | 22 Ft " | 5 Ft " |
| 18 | 21 Ft " | 33 Ft " |
| 19 | 20 Ft " | 20 Ft " |
| 20 | 15 Ft " | 45 Ft " |
| 21 | 15 Ft " | 10 Ft " |
| 22 | 30 Ft " | 10 Ft " |
| 23 | 10 Ft " | 20 Ft " |
| 24 | 10 Ft " | 25 Ft " |
| 25 | 5 Ft " | 15 Ft " |
| 26 | 10 Ft " | 20 Ft " |
| 27 | 10 Ft " | 23 Ft " |
| 28 | 55 Ft " | 15 Ft " |
| 29 | 10 Ft " | 30 Ft " |
| 30 | 30 Ft " | 15 Ft " |
| 31 | 18 Ft " | 20 Ft " |
| 32 | 15 Ft " | 20 Ft " |
| 33 | 15 Ft " | 20 Ft " |
| 34 | 10 Ft " | 21 Ft " |
| 35 | 10 Ft " | 25 Ft " |
| 36 | 25 Ft " | 25 Ft " |
| 37 | 10 Ft " | 20 Ft " |
| 38 | 20 Ft " | 30 Ft " |
| 39 | 20 Ft " | 40 Ft " |
| 40 | 10 Ft " | 15 Ft " |
| 41 | 15 Ft " | 30 Ft " |
| 42 | 10 Ft " | 22 Ft " |
| 43 | 25 Ft " | 30 Ft " |
| 44 | 15 Ft " | 20 Ft " |

K-145

| ITEM NO. | FUZE TORQUE | BURSTER TORQUE |
|---|---|---|
| 45 | 25 Ft Lb | 28 Ft Lb |
| 46 | 25 Ft " | 10 Ft " |
| 47 | 20 Ft " | 30 Ft " |
| 48 | 21 Ft " | 25 Ft " |
| 49 | 10 Ft " | 28 Ft " |
| 50 | 15 Ft " | 2 Ft " |
| 51 | 18 Ft " | 25 Ft " |
| 52 | 20 Ft " | 15 Ft " |
| 53 | 15 Ft " | 25 Ft " |
| 54 | 18 Ft " | 30 Ft " |
| 55 | 25 Ft " | 25 Ft " |
| 56 | 10 Ft " | 30 Ft " |
| 57 | 20 Ft " | 40 Ft " |
| 58 | 10 Ft " | 10 Ft " |
| 59 | 10 Ft " | 15 Ft " |
| 60 | 10 Ft " | 30 Ft " |
| 61 | 35 Ft " | 35 Ft " |
| 62 | 25 Ft " | 15 Ft " |
| 63 | 25 Ft " | 20 Ft " |
| 64 | 10 Ft " | 30 Ft " |
| 65 | 18 Ft " | 28 Ft " |
| 66 | 35 Ft " | 20 Ft " |
| 67 | 20 Ft " | 15 Ft " |
| 68 | 20 Ft " | 15 Ft " |
| 69 | 30 Ft " | 25 Ft " |
| 70 | 20 Ft " | 25 Ft " |
| 71 | 20 Ft " | 25 Ft " |
| 72 | 20 Ft " | 18 Ft " |
| 73 | 12 Ft " | 20 Ft " |
| 74 | 25 Ft " | 30 Ft " |
| 75 | 35 Ft " | 25 Ft " |
| 76 | 50 Ft " | 25 Ft " |
| 77 | 30 Ft " | 20 Ft " |
| 78 | 20 Ft " | 15 Ft " |
| 79 | 20 Ft " | 30 Ft " |
| 80 | 10 Ft " | 15 Ft " |
| 81 | 20 Ft " | 25 Ft " |
| 82 | 35 Ft " | 2 Ft " |
| 83 | 30 Ft " | 15 Ft " |
| 84 | 40 Ft " | 15 Ft " |
| 85 | 40 Ft " | 25 Ft " |
| 86 | 15 Ft " | 20 Ft " |
| 87 | 30 Ft " | 10 Ft " |
| 88 | 150 Ft " | 25 Ft " |
| 89 | 35 Ft " | 10 Ft " |

K-146

| ITEM NO. | FUZE TORQUE | BURSTER TORQUE |
|---|---|---|
| 90 | 40 Ft Lb | 25 Ft Lb |
| 91 | 50 Ft " | 10 Ft " |
| 92 | 30 Ft " | 15 Ft " |
| 93 | 5 Ft " | 10 Ft " |
| 94 | 30 Ft " | 40 Ft " |
| 95 | 35 Ft " | 20 Ft " |
| 96 | 30 Ft " | 25 Ft " |
| 97 | 10 Ft " | 30 Ft " |
| 98 | 80 Ft " | 110 Ft " |
| 99 | 10 Ft " | 5 Ft " |
| 100 | 150 Ft " | 40 Ft " |
| 101 | 50 Ft " | 30 Ft " |
| 102 | 35 Ft " | 45 Ft " |
| 103 | 40 Ft " | 40 Ft " |
| 104 | 40 Ft " | 30 Ft " |
| 105 | 55 Ft " | 28 Ft " |
| 106 | 70 Ft " | 35 Ft " |
| 107 | 50 Ft " | 25 Ft " |
| 108 | 40 Ft " | 30 Ft " |
| 109 | 30 Ft " | 15 Ft " |
| 110 | 15 Ft " | 30 Ft " |
| 111 | 10 Ft " | 10 Ft " |
| 112 | 35 Ft " | 25 Ft " |
| 113 | 150 Ft " | 30 Ft " |
| 114 | 35 Ft " | 25 Ft " |
| 115 | 50 Ft " | 35 Ft " |
| 116 | 50 Ft " | 35 Ft " |
| 117 | 35 Ft " | 5 Ft " |
| 118 | 30 Ft " | 25 Ft " |
| 119 | 60 Ft " | 10 Ft " |
| 120 | 35 Ft " | 5 Ft " |
| 121 | 60 Ft " | 30 Ft " |
| 122 | 30 Ft " | 28 Ft " |
| 123 | 50 Ft " | 25 Ft " |
| 124 | 40 Ft " | 35 Ft " |
| 125 | 30 Ft " | 28 Ft " |
| 126 | 15 Ft " | 10 Ft " |
| 127 | 25 Ft " | 25 Ft " |
| 128 | 30 Ft " | 35 Ft " |
| 129 | 30 Ft " | 20 Ft " |
| 130 | 40 Ft " | 25 Ft " |
| 131 | 10 Ft " | 15 Ft " |
| 132 | 35 Ft " | 20 Ft " |
| 133 | 50 Ft " | 20 Ft " |
| 134 | 25 Ft " | 35 Ft " |

K-147

| ITEM NO. | FUZE TORQUE | BURSTER TORQUE |
|---|---|---|
| 135 | 25 Ft Lb | 10 Ft Lb |
| 136 | 15 Ft " | 25 Ft " |
| 137 | 10 Ft " | 40 Ft " |
| 138 | 20 Ft " | 30 Ft " |
| 139 | 100 Ft " | 20 Ft " |
| 140 | 35 Ft " | 25 Ft " |
| 141 | 20 Ft " | 10 Ft " |
| 142 | 5 Ft " | 35 Ft " |
| 143 | 5 Ft " | 35 Ft " |
| 144 | 15 Ft " | 20 Ft " |
| 145 | 10 Ft " | 30 Ft " |
| 146 | 10 Ft " | 30 Ft " |
| 147 | 30 Ft " | 40 Ft " |
| 148 | 20 Ft " | 45 Ft " |
| 149 | 15 Ft " | 35 Ft " |
| 150 | 25 Ft " | 40 Ft " |
| 151 | 25 Ft " | 60 Ft " |
| 152 | 15 Ft " | 30 Ft " |
| 153 | 10 Ft " | 35 Ft " |
| 154 | 100 Ft " | 40 Ft " |
| 155 | 20 Ft " | 30 Ft " |
| 156 | 10 Ft " | 35 Ft " |
| 157 | 10 Ft " | 10 Ft " |
| 158 | 2 Ft " | 15 Ft " |
| 159 | 35 Ft " | 30 Ft " |
| 160 | 2 Ft " | 35 Ft " |
| 161 | 10 Ft " | 20 Ft " |
| 162 | 30 Ft " | 20 Ft " |
| 163 | 15 Ft " | 35 Ft " |
| 164 | 20 Ft " | 15 Ft " |
| 165 | 45 Ft " | 20 Ft " |
| 166 | 40 Ft " | 20 Ft " |
| 167 | 30 Ft " | 10 Ft " |
| 168 | 35 Ft " | 10 Ft " |
| 169 | 10 Ft " | 2 Ft " |
| 170 | 15 Ft " | 35 Ft " |
| 171 | 30 Ft " | 10 Ft " |
| 172 | 90 Ft " | 30 Ft " |
| 173 | 40 Ft " | 30 Ft " |
| 174 | 20 Ft " | 45 Ft " |
| 175 | 15 Ft " | 40 Ft " |
| 176 | 35 Ft " | 30 Ft " |
| 177 | 25 Ft " | 35 Ft " |
| 178 | 25 Ft " | 10 Ft " |
| 179 | 35 Ft " | 15 Ft " |

K-148

| ITEM NO. | FUZE TORQUE | BURSTER TORQUE |
|---|---|---|
| 180 | 15 Ft Lb | 60 Ft Lb |
| 181 | 40 Ft " | 45 Ft " |
| 182 | 45 Ft " | 30 Ft " |
| 183 | 5 Ft " | 15 Ft " |
| 184 | 15 Ft " | 35 Ft " |
| 185 | 20 Ft " | 40 Ft " |
| 186 | 15 Ft " | 45 Ft " |
| 187 | 20 Ft " | 20 Ft " |
| 188 | 20 Ft " | 30 Ft " |
| 189 | 25 Ft " | 25 Ft " |
| 190 | 30 Ft " | 15 Ft " |
| 191 | 45 Ft " | 40 Ft " |
| 192 | 10 Ft " | 10 Ft " |
| 193 | 30 Ft " | 15 Ft " |
| 194 | 35 Ft " | 10 Ft " |
| 195 | 20 Ft " | 25 Ft " |
| 196 | 40 Ft " | 35 Ft " |
| 197 | 30 Ft " | 40 Ft " |
| 198 | 20 Ft " | 20 Ft " |

K-149

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
|---|---|---|
| 1. REPORT NUMBER<br>DRCPM-DRD-TR-77020 | 2. GOVT ACCESSION NO. | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle)<br>Final Demilitarization Plan; Operation of the CAMDS at Tooele Army Depot Inclosure 11 - Demilitarization Machine Testing and Related Data | | 5. TYPE OF REPORT & PERIOD COVERED<br>Final - 1977 |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s) | | 8. CONTRACT OR GRANT NUMBER(s) |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>OFFICE OF THE PROJECT MANAGER FOR CHEMICAL DEMILITARIZATION AND INSTALLATION RESTORATION<br>ABERDEEN PROVING GROUND, MARYLAND 21010 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>OFFICE OF THE PROJECT MANAGER FOR CHEMICAL DEMILITARIZATION AND INSTALLATION RESTORATION<br>ABERDEEN PROVING GROUND, MARYLAND 21010 | | 12. REPORT DATE<br>March 1977 |
| | | 13. NUMBER OF PAGES<br>128 |
| 14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) | | 15. SECURITY CLASS. (of this report)<br>UNCLASSIFIED |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release: Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Chemical Agent/Munition Disposal System
Chemical Demilitarization
Demilitarization Machinery
Rocket Propellant Tests
Tooele Army Depot, Utah
Projectile Demilitarization
Mine Demilitarization
Mortar Demilitarization


20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Chemical Agent Munition Disposal System (CAMDS) is a prototype facility for the large scale destruction of lethal chemical agents and munitions. This document contains description and results of testing of demilitarization machines being developed for the CAMDS.


100

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

## INSTRUCTIONS FOR PREPARATION OF REPORT DOCUMENTATION PAGE

RESPONSIBILITY. The controlling DoD office will be responsible for completion of the Report Documentation Page, DD Form 1473, in all technical reports prepared by or for DoD organizations.

CLASSIFICATION. Since this Report Documentation Page, DD Form 1473, is used in preparing announcements, bibliographies, and data banks, it should be unclassified if possible. If a classification is required, identify the classified items on the page by the appropriate symbol.

### COMPLETION GUIDE

General. Make Blocks 1, 4, 5, 6, 7, 11, 13, 15, and 16 agree with the corresponding information on the report cover. Leave Blocks 2 and 3 blank.

Block 1. Report Number. Enter the unique alphanumeric report number shown on the cover.

Block 2. Government Accession No. Leave Blank. This space is for use by the Defense Documentation Center.

Block 3. Recipient's Catalog Number. Leave blank. This space is for the use of the report recipient to assist in future retrieval of the document.

Block 4. Title and Subtitle. Enter the title in all capital letters exactly as it appears on the publication. Titles should be unclassified whenever possible. Write out the English equivalent for Greek letters and mathematical symbols in the title *(see "Abstracting Scientific and Technical Reports of Defense-sponsored RDT/E," AD-667 000)*. If the report has a subtitle, this subtitle should follow the main title, be separated by a comma or semicolon if appropriate, and be initially capitalized. If a publication has a title in a foreign language, translate the title into English and follow the English translation with the title in the original language. Make every effort to simplify the title before publication.

Block 5. Type of Report and Period Covered. Indicate here whether report is interim, final, etc., and, if applicable, inclusive dates of period covered, such as the life of a contract covered in a final contractor report.

Block 6. Performing Organization Report Number. Only numbers other than the official report number shown in Block 1, such as series numbers for in-house reports or a contractor/grantee number assigned by him, will be placed in this space. If no such numbers are used, leave this space blank.

Block 7. Author(s). Include corresponding information from the report cover. Give the name(s) of the author(s) in conventional order *(for example, John R. Doe or, if author prefers, J. Robert Doe)*. In addition, list the affiliation of an author if it differs from that of the performing organization.

Block 8. Contract or Grant Number(s). For a contractor or grantee report, enter the complete contract or grant number(s) under which the work reported was accomplished. Leave blank in in-house reports.

Block 9. Performing Organization Name and Address. For in-house reports enter the name and address, including office symbol, of the performing activity. For contractor or grantee reports enter the name and address of the contractor or grantee who prepared the report and identify the appropriate corporate division, school, laboratory, etc., of the author. List city, state, and ZIP Code.

Block 10. Program Element, Project, Task Area, and Work Unit Numbers. Enter here the number code from the applicable Department of Defense form, such as the DD Form 1498, "Research and Technology Work Unit Summary" or the DD Form 1634. "Research and Development Planning Summary," which identifies the program element, project, task area, and work unit or equivalent under which the work was authorized.

Block 11. Controlling Office Name and Address. Enter the full, official name and address, including office symbol, of the controlling office. *(Equates to funding/sponsoring agency. For definition see DoD Directive 5200.20, "Distribution Statements on Technical Documents.")*

Block 12. Report Date. Enter here the day, month, and year or month and year as shown on the cover.

Block 13. Number of Pages. Enter the total number of pages.

Block 14. Monitoring Agency Name and Address *(if different from Controlling Office)*. For use when the controlling or funding office does not directly administer a project, contract, or grant, but delegates the administrative responsibility to another organization.

Blocks 15 & 15a. Security Classification of the Report: Declassification/Downgrading Schedule of the Report. Enter in 15 the highest classification of the report. If appropriate, enter in 15a the declassification/downgrading schedule of the report, using the abbreviations for declassification/downgrading schedules listed in paragraph 4-207 of DoD 5200.1-R.

Block 16. Distribution Statement of the Report. Insert here the applicable distribution statement of the report from DoD Directive 5200.20, "Distribution Statements on Technical Documents."

Block 17. Distribution Statement *(of the abstract entered in Block 20, if different from the distribution statement of the report)*. Insert here the applicable distribution statement of the abstract from DoD Directive 5200.20, "Distribution Statements on Technical Documents."

Block 18. Supplementary Notes. Enter information not included elsewhere but useful, such as: Prepared in cooperation with . . . Translation of *(or by)* . . . Presented at conference of . . . To be published in . . .

Block 19. Key Words. Select terms or short phrases that identify the principal subjects covered in the report, and are sufficiently specific and precise to be used as index entries for cataloging, conforming to standard terminology. The DoD "Thesaurus of Engineering and Scientific Terms" *(TEST)*, AD-672 000, can be helpful.

Block 20. Abstract. The abstract should be a brief *(not to exceed 200 words)* factual summary of the most significant information contained in the report. *If possible, the abstract of a classified report should be unclassified and the abstract to an unclassified report should consist of publicly- releasable information. If the report contains a significant bibliography or literature survey, mention it here.* For information on preparing abstracts see "Abstracting Scientific and Technical Reports of Defense-Sponsored RDT&E," AD-667 000.

★ U.S. GPO: 1974—540-847/9082